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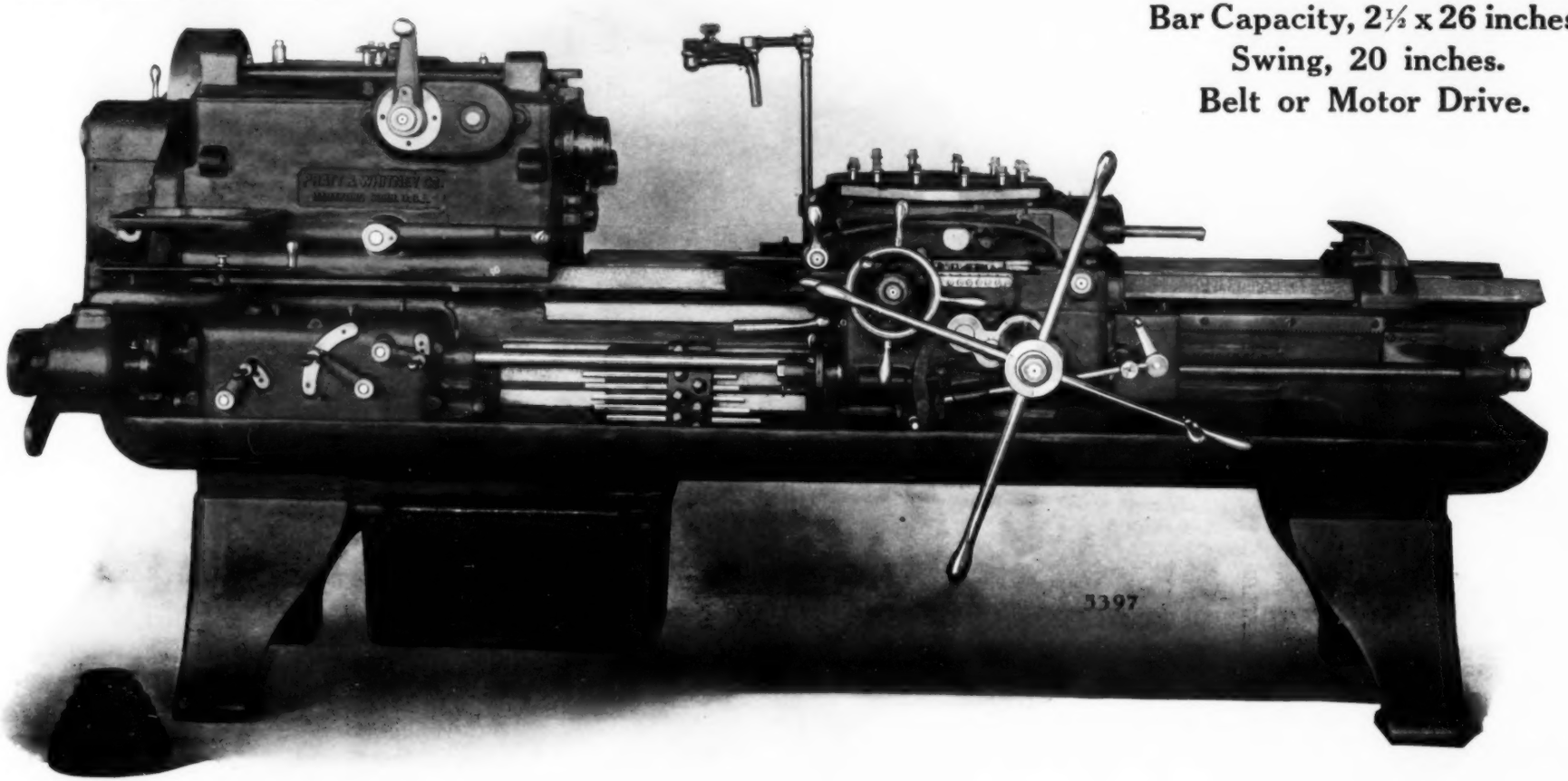


Manufacturing a Planer Feed Gear

By F. A. Stanley

A new form of feed gear for planers in which the parts are all self contained and inclosed in the body of the device. A set of useful manufacturing fixtures of simple construction which enable the feed gear parts to be turned out economically and upon a thoroughly interchangeable basis.

Some unusual tools for performing milling, punching, scribing and other operations. How they are constructed and used.

The feed gear or "trigger gear" applied to the planers built by the Cincinnati Planer Company, Cincinnati, Ohio, is of novel design and of compact construction. It is a complete unit, self contained, with all of the mechanism inclosed with the exception of the small handle which operates the feed pawl, and it may be removed from the feed rod or screw with all the parts remaining intact.

Some Features of Construction

This feed gear unit is shown assembled at *A*, Fig. 1, and the different parts entering into its construction are shown to the right in the same engraving. Several of the members are also illustrated by the line drawing, Fig. 2. The device consists of a central hub or bush *B* bored and splined for a key to suit the end of the feed rod or screw, and adapted to receive the operating gear *C* which is free to rotate between the flange on the end of the bush and the retaining ring *D* secured near the end of the bush.

The carrying member *B* is milled crosswise to form a pocket to receive the pawl *E* which is normally held in neutral position by a flat spring plate *F* seated at the bottom of the milled opening. The pawl is turned to bring either of its operating edges into working position by the handle *G* projecting from the face of the bush *B*. The edge of the pawl, when set in operative position, is held by the spring pressure upon the flat lower face of the pawl body, in contact with the interior of the gear ring *C* so that it engages the notches cut in that ring, and movement of the gear is transmitted through the pawl to the bush and to the feed rod or screw in either direction according to which end of the pawl is set in working relation with the gear.

In Fig. 1 the pawl is shown in neutral position as indicated by the location of the cross-pin handle *G* which is square with the keyway in the bore of the bush. This handle is turned to right or left according to the direction required for the feed.

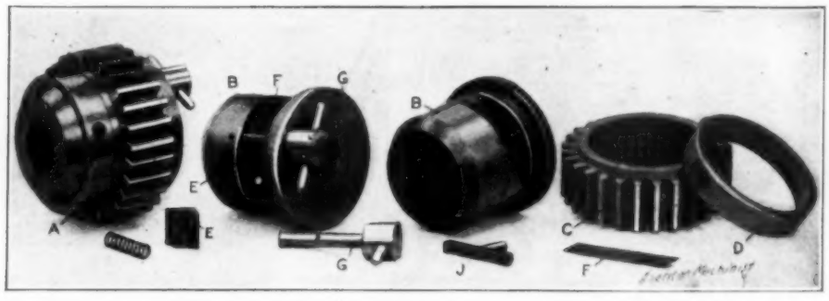


Fig. 1. Planer Feed Gear Assembled and Taken Apart

Indexing Fixture for the Keyseater

The tools used in the manufacture of these trigger gear parts make them interchangeable throughout and a number of these special tools are illustrated in the engravings.

Fig. 3 shows a fixture by means of which the operating notches in the bore of the gear ring are cut, two at a time, in the keyseater. The base of the fixture is provided with a locking pin for engaging the notches in the index plate, the plates being made to suit the number of notches required in the gear. This fixture is adapted for handling a number of different sizes of gears and in changing from one job to another, the index plate and the sleeve which receives the work are selected to suit the piece.

Although the gear to be notched internally fits fairly closely in its retaining ring in the fixture, it is actually centered by a beveled surface inside the locking ring *H*, which, when screwed down on the threaded nose of the fixture, draws the work down in its seat and holds it central during the cutting operation. The notching tool will be seen at *I* and is shown more clearly in the sketch, Fig. 4. As it has two cutting points the index ring has only one-half the number of notches which are required to be cut in the gear ring. The tool is carried in the keyseater bar and as indicated by the sketch, Fig. 4, the teeth on the tool are located radially, the center lines converging at the center of the bore of the feed gear, so that each notch is cut in the same position as if produced with a single-point cutter with the work indexed one space for each notch.

Some Drilling Jigs

In Figs. 5 and 6 are illustrated some simple and efficient drilling jigs which handle various parts conveniently and assist very materially in the production of interchangeable work.

The bush *B*, after it has been turned out in the turret lathe, is splined to receive the stem key *J*, Fig. 1, and this keyway is then used as a means of locating the piece for further operations. It is first slipped on a stud in a milling fixture where it is located by a key while the rectangular cut *K* is milled across for the reception of the pawl and spring plate *F*, Fig. 1. It is then ready for jigs *L* and *M*,

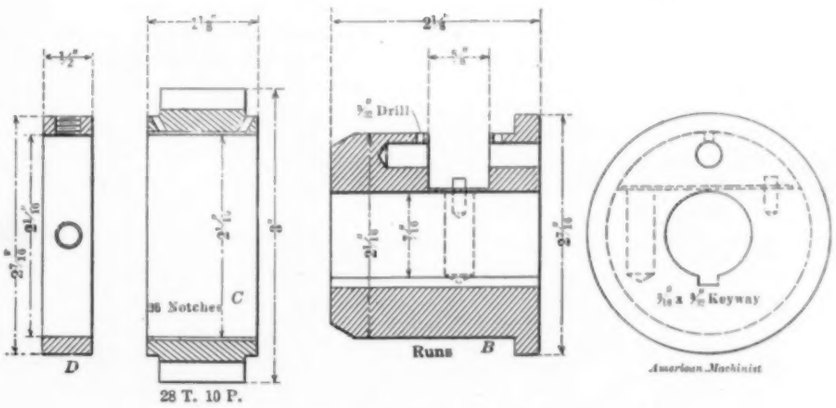


Fig. 2. Details of Planer Feed Gear

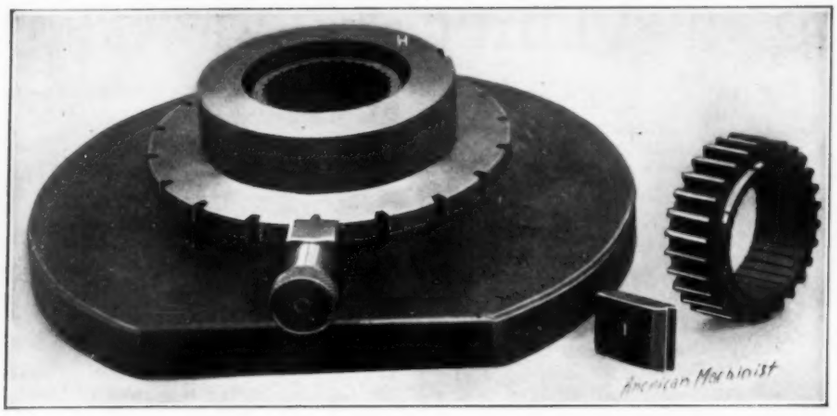


FIG. 3. INDEXING FIXTURE FOR CUTTING NOTCHES IN FEED GEAR

Fig. 5, in the former of which two holes are drilled as shown at *N* and *O* for the pin and spring pin which control the flat plate *F* under the pawl. Jig *M* is used for drilling a hole to receive the stem on key *J*, Fig. 1. In both jigs the work is located by the keyway which fits over a key in the holding stud.

being $\frac{5}{8}$ inch. In locating the block in the drill jig *P*, Fig. 5, it is placed against stop pins to position it endwise and pressed firmly against two square faces by the operating screw in the jig which forces a round shoe against the lower corner of the pawl block. Here the small pin hole is drilled with the assurance that

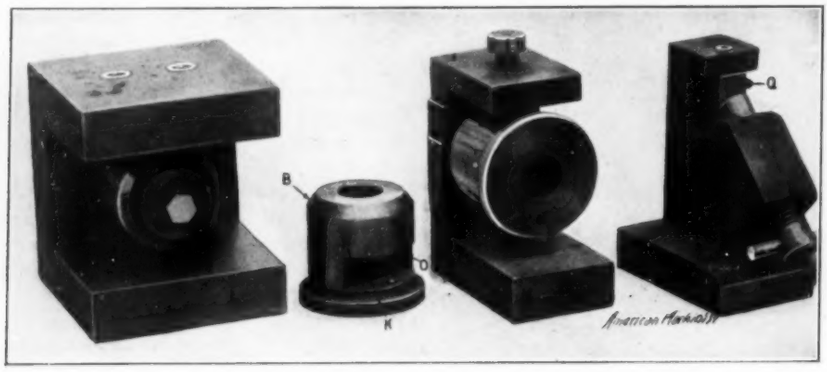


FIG. 5. A GROUP OF DRILL JIGS

DRILLING THE PAWL BLOCKS

The jig at *P*, Fig. 5, is designed for drilling a small hole for the pin which locates the pawl in the correct position endwise and at the right angle upon the operating stud *G*, Fig. 1. The pawl is made from a block seen at *Q*, Figs. 5 and 6, which is cut to length from a bar of steel about one-half inch square, the length of the block in the size illustrated

it shall be the exact distance required from the end of the block and perfectly square with the block faces.

The block is placed as at *Q*, Fig. 6, for the drilling of the longitudinal hole which receives the body of the operating pin *G*. This jig has a seat cut in at right angles to receive the work and the latter is held back in place by the swinging latch which when closed is drawn securely against the

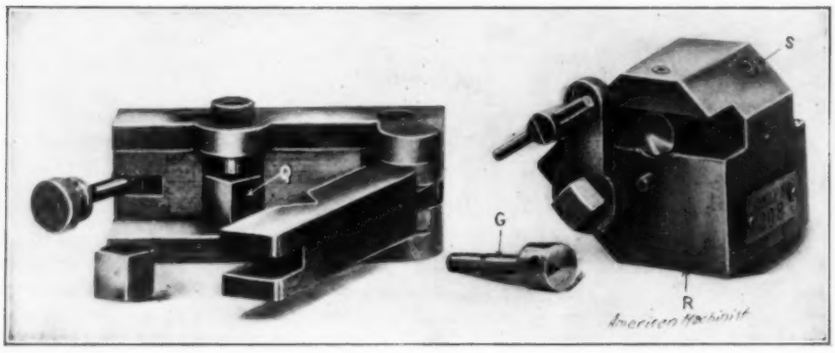


FIG. 6. TWO SMALL DRILL JIGS

two exposed faces of the pawl block by the nurled nut on the swinging bolt.

A JIG FOR TWO PIN HOLES

The other jig, *R*, in Fig. 6 handles the

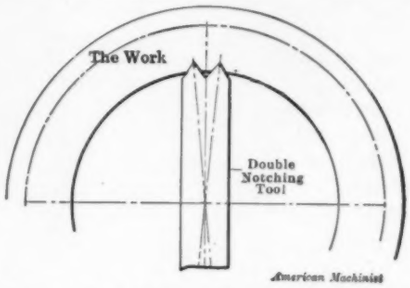


FIG. 4. THE DOUBLE TOOL FOR PLANING NOTCHES ON RADIAL LINES IN FEED-GEAR RING

pawl-operating pin *G*. This pin is slid into a chamber drilled through the block and pressed back in place by the screw carried in the swinging arm which is shown moved to the left to allow the work to be entered or removed. The drill bushing for the pin hole through the head of part *G* and for the small pin which holds the pawl in place are shown in the

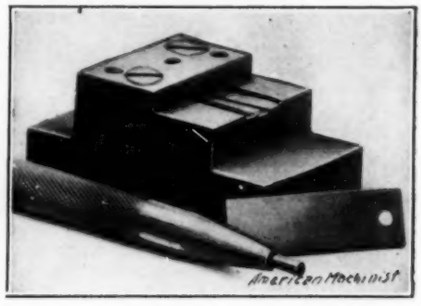


FIG. 8. HAND-OPERATED PUNCH AND DIE

upper faces of the jig. The bottom of the jig is provided with two faces planed at angles corresponding to the faces in which the two drill bushings are fitted so that when rested upon these faces the jig is correctly placed for the drilling operations. The smaller hole, which is drilled with the aid of bushing *S*, is the more

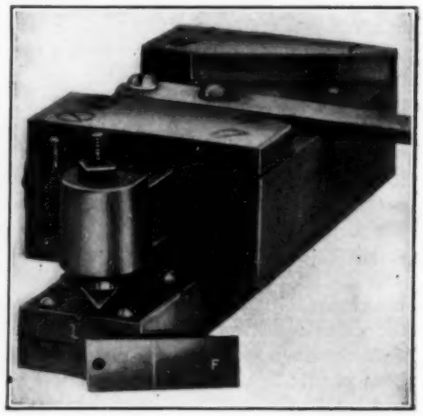


FIG. 9. A SCRIBING FIXTURE

important of the two as this determines the position of the pawl upon its carrying pin *G*, and to insure interchangeability this small pin hole must be an exact distance from the shoulder under the head of pin *G* and must also be at the required angle with the hole for the handle through the head of *G*, otherwise this handle will not lie horizontally when the pawl is set in neutral position in the assembled feed gear.

A Milling Operation

After the pawl blocks are drilled they are milled to the required form shown at *E*, Fig. 1, in the fixture seen in Fig. 7. Here the block is slipped on a locating pin which passes through holes drilled in the top of the fixture and while positioned on this pin the work is kept from turning by a small V-block pressed upward by a cone point on the inner end of screw *T*. The milling cut is then taken across the block with the gang cutters illustrated, these forming the neat, rounded surface at the top, with the two flat faces and dressing off the two sharp corners which constitute the working ends of the pawl. The pawl is then ready for hardening and assembling upon its operating pin.

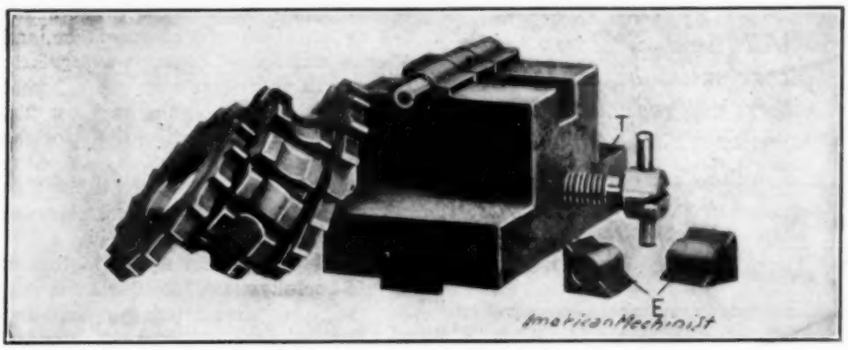


Fig. 7. A Form-milling Fixture

A Hand-operated Punch and Die

The thin steel plate used under the pawl to hold the latter either in engagement or disengaged from the feed gear is provided with a hole at one end which locates it upon a pin in its seat in the body or bush *B*, Fig. 1, while the opposite end of the piece of steel rests upon a spring plunger whose position is clearly shown in the drawing, Fig. 2. A light line, which can hardly be called a groove, is scratched across the face of the steel plate to form a detent to hold the pawl in neutral position when its sharp, lower corner is engaged by the shallow cut on the plate. The hole for the pin is punched by the tools in Fig. 8 and the line is scribed with the device shown in Fig. 9.

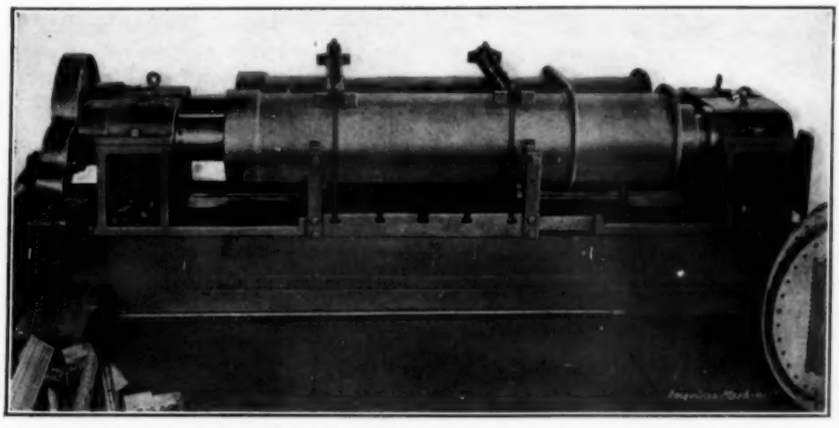
The punch and die, Fig. 8, are hand tools used on the bench. The thin plate to be punched is of spring steel and would be a difficult piece to drill in a jig. By converting the jig into a die, however, and using a punch in place of a drill, the work is simplified and enough pieces can be punched in a short time to last indefinitely. The punch itself is 6 or 7 inches long and has a large nurled body so that it may be readily held in the hand. The cutting end fits nicely in a bushing and the end is sheared to give a clean cut. The piece of spring steel is slid into a seat under the guide for the punch and a light, quick blow of the hammer gives a clean cut hole in the right location in the plate.

A Scribing Fixture

The scribing fixture referred to is illustrated clearly in Fig. 9 and consists of a base with a suitable locating seat for the steel piece *F* across which the line is to be cut. In this base block there is a slide operated by a handle and carrying at its front end a cone pointed tool which gives a shallow cut or depression just deep enough to lock the pawl in neutral position when engaged with the sharp corner at the bottom of the pawl block. This fixture is used in the bench vise and enables a large number of pieces to be handled in a comparatively short time. Like all of the fixtures shown it is very simple, quite inexpensive and is made to do its work with the necessary degree of accuracy.

A Special Boring Rig

The accompanying illustration shows a special boring rig used at the Fore River Shipbuilding Company's yards, Quincy, Mass., for boring bronze torpedo tubes. The rig is set up on a large surface plate and consists essentially of two main castings, one of which we may perhaps style the headstock, and the other the footstock, having bearings for the journals of two large boring bars. Between these two head castings is a clamping device for the twin torpedo tube. At one end the bars are driven through a system of gearing from an individual motor. The cutting tools are carried on suitable heads on the bars and the feed is by the usual star method. The rig is an ingenious device for machining a special job and represents an enormous saving in money over the cost of a boring mill of sufficient capacity to handle the work.



A Special Boring Rig

Do not continue to grind with the wrong speed to save the price of new pulley. Correct speed will save the price of pulley many times over. Always true the wheel for cylindrical grinding at the speed you are to use it. A wheel that works successfully on a piece of work of small diameter may not be successful on a piece of larger diameter. Diameter of work to be ground is a factor in the selection of a wheel which is many times not reckoned with. Work of a larger diameter means broad, or long, wheel contact, and requires a softer wheel than work of small diameter where the contact is narrow, or short.

As evidence, if any is needed, of the tremendous utility the Panama canal will become, official records show that during 1909 eighty two million dollars' worth of merchandise originating in the United States crossed the isthmus.

Orders, Records, Expense Accounts

By Holden A. Evans *

Forms that are ideal in one place may be entirely unsuited in another.

The authority for all shop work should be the production order, signed by some responsible official.

All time of every employee must be charged to either a production or an expense order.

Cost data should be used, not treated as mere records.

A schedule for general expense.

In outlining the cost system no attempt will be made to describe an organization, and but few forms will be given. In the first place, to describe an organization giving all forms will require more space than is available, and in the second place there is but little advantage gained in doing this. Conditions vary so greatly that an organization and forms which are ideal for one establishment will be entirely unsuited to another. The general principles are, however, the same, and when these are understood it is not difficult, in devising the details, to apply these principles to the conditions existing in each shop.

In any but the smallest establishments there are usually several shops or departments, and in the system outlined provision will be made for several shops. If it is desired to apply the methods described to an establishment with but one shop, this can readily be done. I have selected a shipyard as an example, because it contains many dissimilar shops, and further because I have been intimately associated with shipyard accounts and management for many years.

*Naval constructor, United States Navy.

Uniform Size Blank Forms

Too often little attention is given to uniform sizes for blank forms. In many establishments practically every blank is of a different size. This makes filing more difficult and there are no advantages. The forms can and should be reduced to a few standard sizes and every new blank should be made to conform to a standard size. Vertical filing is generally used and has many advantages. The standard sizes selected for forms should fit standard vertical filing cases. All cost records should be kept on cards and not in books. The advantages of card records are well known and no comment is required.

The Production Order

The production order, which will be called the "job order," is the authority for the factory to undertake work. It should be signed by the manager or his representative, who is authorized to order work. No work should be undertaken except on written job orders or on standing indirect cost orders. The job order should indicate either on its face, or by accompanying plans and specifications, exactly the work that is to be accomplished. In many repair jobs it is not possible at first to give in detail the work to be accomplished. In such cases a preliminary order should be issued to make a complete survey of the job to determine exactly the work necessary, and when this is accomplished to issue job orders for the work itself. It is very bad practice to issue job orders in general terms and follow the job order with oral instructions for the work actually required.

Job Order No. ..... Title ..... Sub-Title .....
Appropriation ..... General Head .....

NAVY YARD, MARE ISLAND, CAL.,

..... 19.....

Sir:— You will please

	ESTIMATED COST	ACTUAL COST
Labor		
Material		
Indirect		
Total		

Authority .....
Date of Completion .....
To .....

Respectfully,

.....

To be returned to office upon completion of work.

FIG. 1. THE JOB ORDER

The order must at least be in duplicate, one copy to the cost file and one copy to the shop or department that is to do the work. Ordinarily from four to eight copies will be required in order that information can be given to all who are interested or responsible for any part of the work. The order should be typewritten and the paper used should be of a size for the typewriter and permit of manifolding; it should be a standard size, and when a number of copies are regularly required, it is desirable to use different colors, for example, white for cost file, blue to the foreman responsible for the job, pink to other foremen who have some work on the job, salmon to the superintendent, etc. A convenient size and type of job order is shown in Fig. 1.

A regular system for numbering orders should be followed. Job orders for output will be designated by numerals; standing expense orders will be designated by letters; special expense orders will be numerals followed by the classification letters showing the expense account to which the order belongs and into which the cost will be carried for record and for distribution. All service cards for labor performed and requisitions for material obtained will bear the symbol or charge number of the job order for the work which obtains the benefit of the labor and material.

Shop Orders Issued by Authority of the Production Order

It is seldom that all the work required by a production order can be accomplished in one department or one shop. When the work required in several shops is well defined, the foreman having primary cognizance of the whole job is designated on the order and the foremen of other shops having some part of the work are given copies, which is their authority to proceed with this work. In many cases, however, miscellaneous incidental work will be required of shops other than those holding job orders. When work of this kind is required it is obtained by the foreman holding the order issuing a secondary order called a "shop order" for the work desired. This should never be done verbally, but should always be a written order on a standard form and should definitely describe the work to be accomplished. The shop order should bear the same charge number as the production order. In Fig. 2 is shown a shop-order form for output work, which has given satisfaction. In Fig. 3 a shop-order form for expense-account work is shown. It will be noted that the order for the output work does

not require approval, while the expense-account work requires the approval of the shop superintendent.

Mustering the Workmen

There are several satisfactory methods for mustering the workmen. When the plant consists of a number of shops more or less scattered, it is necessary to have a check at the workmen's entrance and also at their places of work. This can best be done in the following manner: A brass numbered check is issued to each workman, the number being the workman's number for the payroll, for tool issues and for charging time. Check boards, one for each shop or trade, are at the entrance to the plant, and the workman as he comes in hangs the check on a hook under his number; when he goes out he removes the check. In this way the checks also serve as a pass into the works. When the muster is over, on muster-check cards the numbers that have *not* mustered are noted and these cards are sent to the office to be checked against the muster-card reports from the shops.

Mfg. Dept. 1101 Navy Yard, Mare Island, Cal.

SHOP ORDER. .....

OUTPUT ACCOUNT.

Job Order No..... Appropriation.....

Title.....Subtitle..... General Head .....

To.....SHOP.

You will do the following work charging labor and material, as above:

Work Should Be Completed by.....

.....

Foreman.....Shop.

Original and duplicate to be forwarded to shop in which work is to be done. Foreman receiving order will put in date of receipt and date on which work will be completed, retain original and immediately return duplicate. When job is completed foreman doing work will fill in actual date of completion and forward to shop that issued the order and if work is satisfactory order will be initialed and returned to the foreman who did the work.

Order Was Received....., And the Work

Will Be Completed.....Foreman.....

Work Actually Completed.....Foreman.....

Is Work Satisfactory?.....

.....

Foreman.

FIG. 2. SHOP ORDER FOR OUTPUT—MADE IN DUPLICATE

Mfg. Dept. 1102 Navy Yard, Mare Island, Cal.

SHOP ORDER. .....

EXPENSE ACCOUNT

Job Order No.....

To.....Shop.

Estimated Cost Labor..... Approved By

Estimated Cost Material.....

.....

Total.....

INSTRUCTIONS.

1. Original and duplicate to be forwarded to the foreman who is to do the work, who will fill in the estimate and forward both copies to the officer authorized to approve the work. After approval both copies will be forwarded to the foreman who is to do the work, who will fill in the date of receipt and date of promised completion, initial, return original, forward duplicate to shop requesting work and proceed with the work.

2. When completed, date of completion will be filled in and original forwarded to foreman requiring work, who will examine work, state if satisfactory, initial and return to foreman who did the work.

WORK REQUIRED.

Work Desired Completed by.....

.....

Foreman.....Shop

Order Was Received....., And the Work

Will Be Completed.....Foreman.....

Work Actually Completed.....Foreman.....

Is Work Satisfactory?.....

.....

Foreman

FIG. 3. SHOP ORDER FOR EXPENSE-ACCOUNT WORK—MADE IN DUPLICATE

Employees arriving late are passed in on special reports made by the gate keeper to the main time office; those leaving at other than the regular quitting time are passed out on foreman's passes which are taken up at the gate and turned in to the main office. In the shops and other places of work there are registering clocks on which each workman is required to register arrival and departure. The clocks also serve to register on the service cards the time of beginning and completing each job. If the clocks are used for the latter purpose, more than one clock will be required for each shop, unless the shop is small, or much time will be lost in workmen going from work to the clock. In shipyards a number of clocks must be maintained for outside work, so that the workman may register where he is working. When it is desired to shift a workman from one place to another a notice to register the next muster at a designated station is placed on his number at the clock and his muster card is placed at the new station. The pay roll is made up by the time section from the muster cards as registered by the clocks. The cost records are made up separately by the cost section from the service cards. The daily charges to jobs as taken from the service cards must check with the total daily pay roll entries from the muster cards. In plants where the work is not widely scattered or where the number of workmen is small, the use of brass checks at the entrance gate may be dispensed with, as the clock muster will fill all requirements.

Record of Labor Charges

The time of all employees must be charged to either a production-job order or an expense order. This should be done by means of the service card. On these are given the job-order number, a brief statement of the work, the workman's name, check number and rate of pay, the hour of beginning and stopping the work and the time employed. There is a separate card for each job and new cards each day. The cards of the day are sent each night to the main office; when work is not completed the card is marked "not finished" and a new duplicate card is made out for the next day. These cards should be made out for the workman, except for the time of starting and stopping a job, and these times should be recorded by the workmen with the registering clocks. The cards should be examined by the subforeman in charge and if correct should be initialed by him.

Jobs of work and the corresponding cards should always be kept ahead of each workman, so that there will be no delays on account of waiting for work. In small shops where there is no routing system, the service cards may be made out by the workman. A service card of a different color should be used for overtime work. In the main office the cards of each shop, trade or department are sorted by job numbers, and the charge

for labor for the day for the shop, trade or department is transferred to the job-order card, which is described below. The service cards are filed by job-order numbers.

Record of Material Charges

Material is obtained by means of requisitions on the storekeeper. A separate requisition is made for each job number, in triplicate, one copy being retained by the shop as a record and also for checking material when received, and two copies go to the storekeeper. The prices are entered on these, and one is sent to the cost department, the other being retained by the store as a voucher for the issue. Miscellaneous minor material is obtained from the shop store on minor-production orders, as outlined above. The charges for supervisory force, general labor, issuing tools, grinding tools, small repairs, and miscellaneous material are made without any special orders, and are charged to standing expense orders which will be given later. Large repairs, while chargeable to the expense accounts, should be made to special expense orders in order that the cost of each job may be ascertained. These charges are transferred at the end of the month to the proper expense account and are distributed to the production orders with the other expenses.

Cost Section Records

The cost section receives each day the service cards showing the distribution of direct labor expenditures are distributed daily to the various orders by shops, trades or departments, as desired. The card is ruled in convenient form to show under each shop, trade or department the daily expenditures for direct labor and the total to date, and also the estimated cost of the work. A convenient form for this purpose is shown in Figs. 4 and 5. The expenditures in each shop are taken from the service cards and entered on the job-order card. At the end of the month the total labor expenditure in each shop is entered in the next to last column of the job-order card. With the expense rates for each shop the indirect charges are entered for each shop in the last column and the total indirect charges determined, and these are transferred, together with the total direct-labor charges, to the cost-of-work card. The information given on the job-order cards can be made of much value. In my work I have required that these cards be delivered each afternoon at four o'clock to the assistant naval constructor in general charge of the work, and by means of the information thus obtained he is able, as described in a previous article, to keep in close touch with the work and the daily charges. The cards are collected at eight o'clock the next morning and returned to the cost section.

JOB ORDER CARD Object _____ Appropriation _____
_____ 191 _____ Subtitle _____ Title _____ Job Order No. _____

SHOP	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Boatbuilder																	
Boilermaker																	
Electrician																	
Joiner																	
Laborer																	
Machinist																	
Molder																	
Painter																	
Patternmaker																	
Sailmaker																	
Sh't. Mt'l. W'k'r																	
Shipfitter																	
Shipsmith																	
Shipwright																	
Coppersmith																	
Total for Day																	
Prior Cost																	
TOTAL																	

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FIG. 4. JOB-ORDER CARD, FRONT SIDE. DIRECT LABOR IS ENTERED DAILY ON THIS CARD

Cost Figures Should Be Used not Treated as Mere Records

At this time I wish to point out that material slips. Once a week these are collected by job numbers, and regular requisitions in duplicate are sent to the storekeeper to cover the issues. These are priced and sent to the cost department. This method allows miscellaneous minor material to be secured without delay and also reduces the paper work by making but one requisition for a number of small items required during the week.

Material drawn out for a job but not used must be credited to the job. This is done by returning the material to store with a credit requisition. The same form is used for credit material as for material drawn, except that the requisition has written across its face, "Credit Material." The material is taken up on the books of the storekeeper, the requisition is priced and a copy sent to the cost department and is entered as credit material on the cost-of-work card. If the excess material can be used on another job in the shop, the credit requisition sent to the storekeeper is accompanied by a regular requisition charging the same material to the new job and the material is retained in the shop.

Labor and Material Charges to Expense Orders

Charges for labor and material to the expense orders are made exactly as for labor to each production order and each expense order, and receives from the storekeeper the priced requisitions of material issued for each order. To record these there are required for each order, whether production or expense, a "job order" card, a "cost of work" card, and a "summary of material requisitions" card. With these three sets of cards the costs can be kept with a small amount of clerical labor, and in a way that will give the manager the information that he requires.

ESTIMATE Appropriation _____
_____ 191 Labor $ _____ Material _____ Indirect _____ Total $ _____ Job Order No. _____

SHOP	18	19	20	21	22	23	24	25	26	27	28	29	30	31	Total	Indirect
Boatbuilder																
Boilermaker																
Electrician																
Joiner																
Laborer																
Machinist																
Molder																
Painter																
Patternmaker																
Sailmaker																
Sheet Metal W'k'r																
Shipfitter																
Shipsmith																
Shipwright																
Coppersmith																
Total for Day																
Prior Cost																
TOTAL																

American Machinist

FIG. 5. JOB-ORDER CARD, BACK. DIRECT LABOR IS ENTERED DAILY. INDIRECT CHARGES AT END OF MONTH

Job Order Card

By means of the job-order cards the there is always strenuous objection from a cost department to any system or scheme which will take records from the files of that department. It will be stated that records will be lost and that such a system will greatly interfere with the work of the cost department. Here again the important objective is forgotten or overshadowed by unimportant or petty details. Far too often the cost department sees only the importance of the costs as records, and the importance of these records in carrying out the real work of the factory is not realized. Unfortunately in the great majority of cases the influence of the cost department is such that its ideas

prevail, and the records of cost might as well be kept in sealed glass cases for all the good they do in giving information to those who are directly responsible for the work and its cost. There is no reason why the record cards should be lost, but even if a card should be lost now and then, new cards can be made with but little clerical labor. It may not please the cost section, but what does it matter if the cards become "dog-eared" and dirty; it only shows that they are serving their legitimate purpose.

The manager should hold the cost department with a firm hand and make that department understand that its principal duty is to furnish information to the superintendents, heads of departments and foremen. Everywhere there is the same complaint from the factory proper of difficulty in obtaining promptly information from the cost department, and in the majority of places those who are responsible for the work have ceased to struggle for information regarding costs. Usually the costs are records, and nothing but records, and are but little more value than waste paper so far as giving assistance in the efficient production of the work.

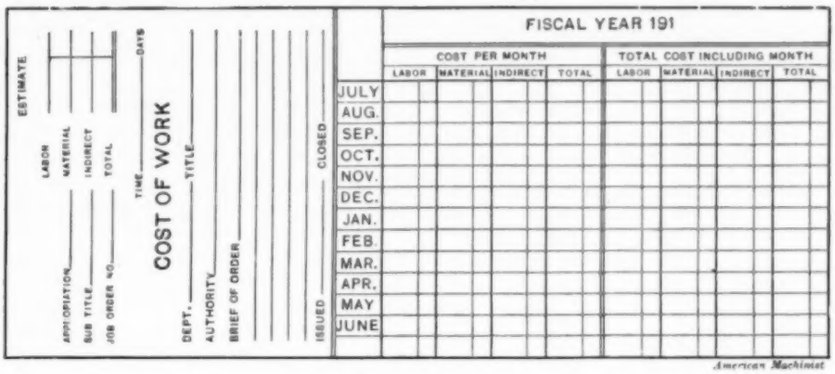


FIG. 6. COST OF WORK CARD—FRONT, THE BACK IS SIMILAR, BUT WITHOUT THE JOB-ORDER DATA

THE COST OF WORK CARD

A convenient form for the cost-of-work card is shown in Fig. 6. On this card there are entered each month, the total direct labor and indirect charges, which are obtained from the job-order card; the material cost for the month, which includes storehouse expense, and the net total cost of material, which includes deductions for "credit material," which data are obtained from the summary-of-material-requisition cards. The cost-of-work card not only shows current monthly charges under the three heads, labor, material and indirect charges, but also shows the total cost to the end of the month under each of these heads. The estimated cost of the work is also given on this card.

SUMMARY OF MATERIAL REQUISITIONS

The priced requisitions for material are received by the cost section from the storekeeper as the issues are made. At the end of the month the requisitions for the month are clipped together, and the total of the issues made up. On the "Summary of Material Requisitions" card, Fig. 7, the numbers of the requisitions and the value of the monthly issue are entered. The storehouse expense percentage is applied and the total cost of the material determined. To this is added the prior cost, and the credit material is subtracted, giving the total net cost of material to the end of the month. No allowance or credit for storehouse expense is made on returned material. The value of the monthly issues and also the total material cost to the end of the month are transferred to the cost-of-work card. The material requisitions clipped together by months are filed with the summary card. At the end of each month the storekeeper furnishes the cost department with a summary of the material issued during the month and the total of the material charged must check with the total given on the summary. It will be noted that but little clerical work is required in recording the material to be charged to each job. There is no copying of material items; the original requisitions serve for checking the materials in the shop, for a voucher to the storekeeper for the issue, and also as a cost record. If it is desired to know in detail the material charged to a job the original requisitions filed with the summary card give this; if only the value is required, it is shown on the cost-of-work card.

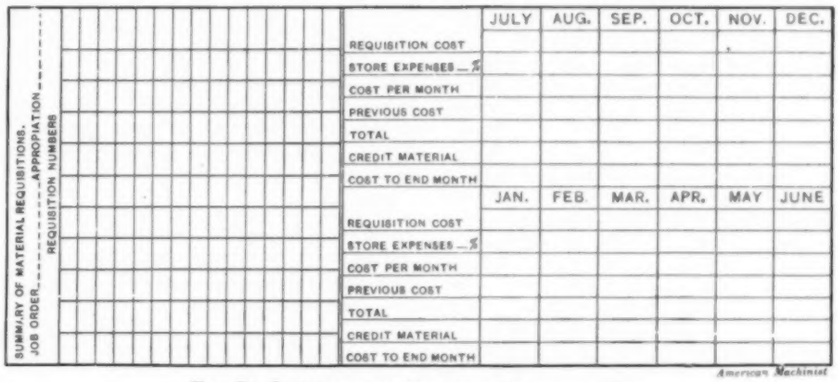


FIG. 7. SUMMARY OF MATERIAL REQUISITIONS

ADVANTAGES AND DISADVANTAGES

The job-order card shows the expenditures for direct labor day by day, and can be checked each day as the work progresses. The cost-of-work card shows the total expenditures month by month, but gives no details of labor or material. If these are required the job-order card and the material requisitions must be consulted. If it is desired to obtain the cost to date of a job at any time except the end of the month, this cannot be done directly; it is necessary to take from the cost-of-work card the cost to the beginning of the month and add the following; direct labor from the job-order card and the estimated indirect charges, direct material from the current month's requisitions plus the percentage of storehouse expense. This, however, can be done very quickly. Any system which requires daily entries to the cost-of-work card for labor and material involves a large amount of clerical work, and also requires a large and unhandy record card. The system described is very simple, requires but little clerical work, and will give very satisfactory results.

INDIRECT CHARGES

The indirect charges will be taken up under the heads of general expense; shop expense; power, heat and light; storehouse expense; part plant development; selling expense.

"G"—GENERAL EXPENSE

Includes salaries of general officers and main-office expense, except those chargeable to selling expense and storehouse expense. Includes fixed charges that cannot be located against a shop or department. Includes labor and material expended for the repair and maintenance of buildings and equipment which cannot be located against a shop or department. Covers all expenditures, the details of which are given below under the subheads:

GA Salaries of general officers and

assistants, excluding storehouse and sales department.

GB Office salaries: Salaries of clerks, messengers, stenographers, janitors and others employed in the general office. Does not include any salaries in storehouse or sales department.

GC Cleaning and care of yard outside of shops: Labor and material expended in cleaning yard. Includes cost of men driving teams for cleaning purposes, but does not include any general stable expense.

GD Drawing office: Salaries of chief draftsmen and others in drawing office when not chargeable direct to output; all drawing-office material; details given under subheads. No charges are made direct to GD, but must be made to subhead symbols.

GE Experiments for the benefit of engineering or manufacturing: Includes labor and material required to make experiments for the benefit of the economical administration of the plant, but does not include costs of experiments for the benefit of a production order, which should be charged direct. No charges will be made to this number except by order from the office.

GG Repairs and maintenance of floating property: Includes labor and material expended in the repair and maintenance of floating property, such as pile drivers, dredges, floats, barges, derricks and launches.

GH Hauling, handling stores and shipping. The cost of hauling and handling material from shop to shop when impracticable to make charges direct to production orders. The cost of boxing and handling for shipment and cost of outgoing freight when impracticable to charge direct to production orders. Does not include hauling and handling material for storehouse which should be charged to storehouse expense. Does not include cost of railway freight service.

GI Stable expense: Includes expense of upkeep of horses, wagons, etc. Drivers should be charged to production orders or to other expense orders.

GJ Legal expense.

GK Dues and assessments for associations and societies.

GL Leave and holidays: Includes pay for officers and others for holidays given with pay.

GM Patents: Cost of obtaining and keeping alive.

GN Telephone and telegraph: Includes all expenses incurred for telephone and telegraph, which are not chargeable to storehouse or sales department. Includes repairs, maintenance and operation of yard telephone service.

GO General office fixtures and furniture: Labor and material for repairs to fixtures and furniture in general offices, not including drawing office, storehouse or sales department. Includes repairs to desks, cabinets, carpets, clocks, bells, safes, calculating machines, window shades, file cases, etc.

GP Plant repairs outside of shops: Labor and material for repair of machinery and equipment outside of shops, or which is not for the use of a single shop. Includes cranes, derricks (not floating), locomotives, locomotive cranes, railroad equipment (not including tracks), etc. Does not include labor and material for *running* these appliances. Repairs estimated to exceed $100 will be made on special orders and charged to this account. These orders will carry no indirect charges.

GQ Operation of plant equipment outside of shops: Labor and material for the operation of railway service, locomotive cranes, derricks, cranes and launches when it is impracticable to make charges direct to production orders.

GR Roads, railway tracks, wharves, and general yard repairs: Labor and material for repair and maintenance of walks, roads, subways, railroad tracks, plate racks, piers and wharves, sewers, fire protection system (not including water system), fences, weighing apparatus, etc. Repairs estimated to exceed $100 will be made to special orders and charged to this account. These orders will carry no indirect charges.

GS Office supplies and postage: Includes all supplies required for the general offices, not including shop, drawing room, storehouse, or sales department offices. Includes books, stationery, postage, newspaper and magazine subscriptions, etc.

GT Traveling expenses: Traveling expenses not chargeable to a particular product and not for the benefit of sales.

GU ————————

GV Miscellaneous: To cover cost of miscellaneous special expenses, such as bad debts, entertaining, etc. No charges to be made to this number without an order from the manager.

GW Watchmen: Labor and material for watchmen service.

GX Part plant development: One-half of cost of charges made under "XG" orders which is not chargeable to any shop or department.

GY ————————

GZ Repairs and maintenance of buildings: Labor and material expended for repairs to buildings, crane runways, lavatories outside of shops, wiring and lights main office, etc., which are not chargeable to shop expense or storehouse expense. Repairs estimated to exceed $100 will be made on special orders and charged to this account. These orders will not carry any indirect expense.

GF Fixed charges: Such as interest, depreciation, taxes, insurance, not chargeable to shops or departments, as per sub-heads given below.

GFD Depreciation not chargeable to a shop or department.

GFF Fire and accident insurance not chargeable to a shop or department.

GFI Interest on investment not chargeable to a shop or department.

GFN Indemnity insurance not chargeable to a shop or department.

GFT Taxes not chargeable to a shop or department.

GD Drawing office:

GDA Miscellaneous wages: Includes the pay of chief draftsman and leading draftsmen and those stowing and recording plans; includes pay of blueprinters; includes the pay of all draftsmen who cannot be charged to production orders, or to the estimating department.

GDB Fixtures and furniture: Includes labor and material expended for repairs and maintenance of drawing tables, fixtures and furniture, and drawing instruments.

GDC Wages of estimating department: Includes the pay of the estimating department and draftsmen engaged on estimates when these charges cannot be made direct to production orders or to the sales department.

GDS Stores and supplies: Includes all stores and supplies, such as ink, paper, tracing cloth, stationery, etc., used in the drawing office and estimating department.

Grease and Oil as Lubricating Materials

By J. Benfiel

There is much truth in the claims for the advantages of grease as a lubricant; at the same time, it has some objectionable features.

In its favor, it can be said that it is clean and requires a minimum of attention, and will go further than an equal amount of oil. One of its most objectionable features is that it forms a hard compound with the small particles of metal rubbed off the shaft and boxes, filling up the oil-ways, and preventing the lubricant reaching all parts of the bearing. It does this especially with a babbitted box. Also, the friction is much greater with the grease when bearing is cold than with oil. The bearing must warm slightly to thin the grease.

I cannot agree with a recent statement in these columns to the effect that most heavy bearings are now equipped with grease cups. In fact, I think a very small per cent. of heavy bearings are so equipped. We use the grease in many places, but think it is hardly the best on heavy journals.

Any bearing should have, in addition to the lubricant necessary to interpose a film between the surfaces, sufficient amount flowing through it to carry out the worn metal and dirt. This the grease as usually supplied to a bearing does not do.

Strain Rods for Hydraulic Presses

By A. Lewis Jenkins*

Formulas for determining the proportions of the tension members between the beam and sill of a hydraulic press, with numerous illustrations of different methods of fastening.

Materials used and allowable working fiber stresses.

*Assistant professor of mechanical engineering, University of Cincinnati.

The design of tension members connecting the beam and sill of a hydraulic press admits of considerable variation, depending upon the design and the purpose of the machine. Structural steel channels riveted to two pairs of channels forming the beam and sill, as shown in Fig. 1, are frequently used. Fig. 2 shows how steel angles are sometimes used when it is desirable to have a wider beam than is possible with the construction shown in Fig. 1. In cases where it is desirable to make the beam and sill, each of two I-beams, steel loops with wood separating posts, as shown in Fig. 3, have proved satisfactory. Although these methods have been extensively employed in the construction of certain classes of machines, they are not usually associated with the common conception of the hydraulic press.

Presses with beams made of wood, cast iron, steel castings, or four or more steel I-beams, are provided with round rods which have indiscriminately been called strain rods, tie rods, posts and columns.

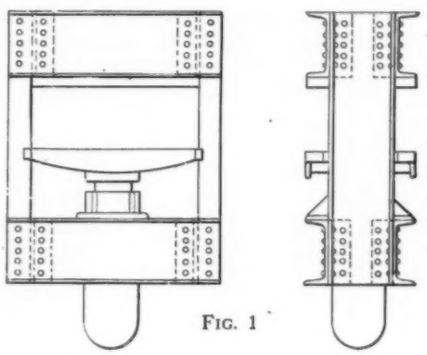


FIG. 1

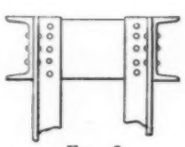


FIG. 2

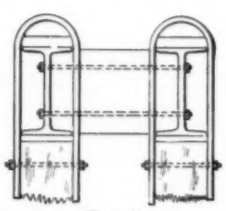


FIG. 3

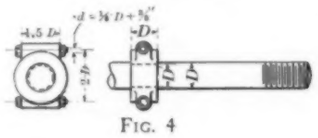


FIG. 4

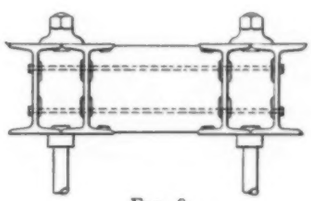


FIG. 8

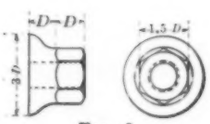


FIG. 9

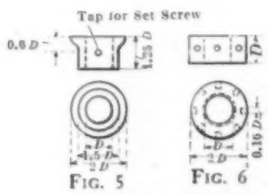


FIG. 5 FIG. 6

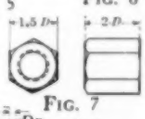


FIG. 7

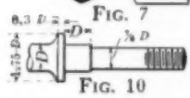


FIG. 10

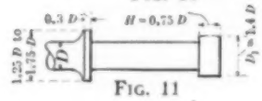


FIG. 11

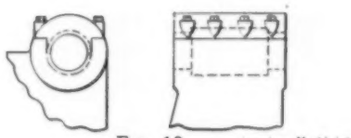


FIG. 12 American Machinist

DETAILS OF BEAMS AND ROD ENDS

MATERIALS

The materials commonly used for rods are wrought iron and soft steel. Ordinary black rod is used on small machines not requiring a finished appearance, and turned shafting where a better appearance is desired. In some cases cold-rolled shafting has been used, but some of its desirable quality is lost by cutting the threads for the nuts. Results of Professor Thurston's experiments show that cold rolling increases the elastic limit 80 to 125 per cent., increases the ultimate strength 25 to 40 per cent. and decreases the ultimate elongation 75 per cent. Nickel steel has also been used for rods.

For presses provided with reliable safety devices that will prevent the pressure from exceeding that for which they are designed, the following working stresses may be used: Black rod, 12,000 to 15,000; bright rod, 14,000 to 16,000; steel forging, 14,000 to 16,000; cold rolled, 15,000 to 20,000; nickel steel, 20,000 to 25,000.

SIZE OF RODS

The number of rods required depends upon the function of the machine; usually, four are necessary and sufficient. In calculating the size of rods an allowance should be made for the lateral thrust of the platen and, in long rods, the elongation due to the load should be taken into account. In many presses the load is not equally distributed among the rods, some carrying more of the load than others, causing unequal elongations which may produce undue stresses in other members of the machine.

PROPORTIONS FOR RODS

The simplest and cheapest construction for strain rods less than 3 inches diameter consists of a round bar of wrought iron or steel, threaded for nuts at each end and provided with split, cast-iron collars fitted as shown in Fig. 4. The collars may have the proportions shown, the inside diameter D' being equal to the diameter at the root of the thread. For small machines a solid collar having the proportions shown in Fig. 5 is secured in place by a set-screw bearing in a "spot" on the rod.

The nuts may be of steel or cast iron. Fig. 6 shows the proportions for round steel nuts, and Fig. 7 a hexagonal cast-iron nut which is extensively used. Where the four-I-beam construction, shown in Fig. 8, is used, it is necessary to have a greater bearing area for the nut, and the proportions shown in Fig. 9 are satisfactory.

Rods that are larger than 3 to 4 inches diameter usually have forged heads, as shown in Fig. 11. The diameter of a forged head depends upon the allowable bearing pressure, which safely may be taken equal to the tensile stress in the rod. Upon this assumption the area of the bearing surface may be equated with the area of the rod, which gives

$$\frac{\pi}{4}(D_1^2 - D^2) = \frac{\pi D^2}{4};$$

from which $D_1 = 1.4\ D$. If chipping blocks are used, as shown in Fig. 14, this value should be increased to

$$D_1 = 1.7\ D.$$

Theoretically, the hight of head depends upon the shearing resistance. By taking the shearing strength of the material equal to 5/6 the tensile strength, and equating with the resistance to tension, the result is:

$$\frac{6}{5}\frac{\pi D^2}{4} = \pi D H;$$

from which

$$H = 0.3\ D.$$

This gives values for the hights of heads that are much less than those used in practice, for the reasons that flaws in this section are frequently incurred by forging, and the prominent location of so small a head detracts from the massive appearance which is a desirable and well defined characteristic of such machines. For the sake of appearance this proportion is allowed to vary somewhat, but for ordinary forms of beams it is good practice to make

$$H = 0.75\ D.$$

When the rod is subjected to a transverse load due to the side thrust of the platen, and the rod diameter is increased accordingly, the portion between the head and collar may be changed to proportions given in Fig. 10.

Several methods are employed for fastening the rod to the beam, the simplest of which is shown in Fig. 12, and consists of a split boss connected with studs or screws. This scheme allows a considerable portion of the load to be taken by the cap, and subjects the studs to severe stress conditions. This objection may be overcome, however, by decreasing the bearing area of the cap, or using the method shown in Fig. 13 for resisting the shear.

There is considerable variation in the shrinkage of cast-iron beams and, quite frequently, considerable metal must be removed from the holes in getting the required distance between centers. Large beams often are provided with chipping blocks, as shown in Fig. 14, and the rod can be fitted by hand in less time than is required to bore the bosses with a machine.

Fig. 15 shows a method that does not require cap plates or threaded rods. The hole in the bearing is large enough to allow the head to pass through and split collars are inserted to hold it in position. This method has no practical advantage over that shown in Fig. 13, is more costly and less rigid.

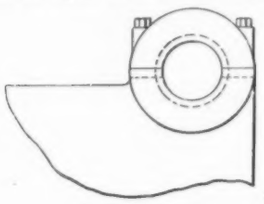
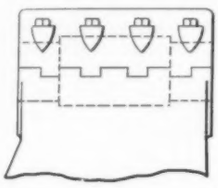


FIG. 13



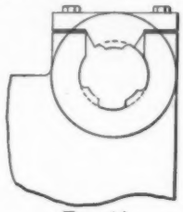


FIG. 14

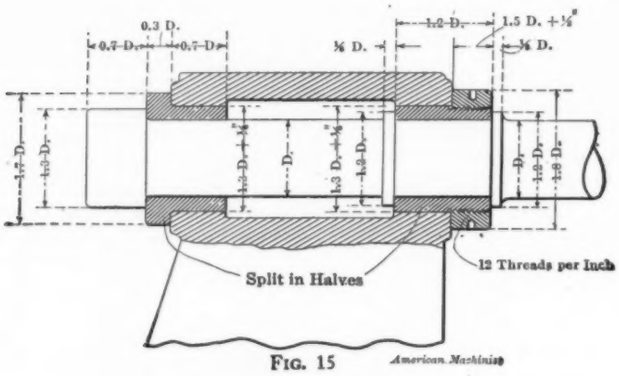


FIG. 15 American Machinist

DETAILS OF STRAIN-ROD COUPLINGS

Noise in Gear Transmissions

By Chas. H. Logue

The causes of noise in gear transmissions are many—among them, in proper selection of materials or combinations of materials, careless mounting and inexact cutting.

Prominent among the causes for noisy gears are the material or combination of materials of which they are constructed, and their location. These, however, are often beyond our control. Accuracy in cutting will avail little if the gear is not properly mounted; poor shaft alinement, carelessness in pressing the gear onto the shaft or driving home a tapered key, will cause a gear to become noisy which has otherwise been properly handled.

PROPER CUTTING

The cutting of the teeth is often a source of noise that it is possible to overcome by employing proper methods. The mounting of the gear on the arbor is of first importance. Even if the gear runs perfectly true there it does not necessarily follow that it will run true when in position on the machine, as the bore may not be concentric with the outside diameter. This is often due to a defective bushing, or to the gear fitting the work arbor loosely, or to the gear being reamed by hand, a practice that should not be tolerated.

If the arbor runs true and the gear does not, and the bore of the gear fits the arbor properly, do not attempt to line it up by placing paper or tin on opposite sides of the flange, either report it defective or cut it as it is, first being assured that things are as stated. For such work the ordinary steady rest will not answer. One carrying a wedge with a back angle of about 15 degrees, held against the rim by a spring acting on the large end of the wedge will adjust itself to any inequality in the gear rim.

Next in importance is the spacing of the teeth. Poor spacing is enough in itself to cause plenty of noise; for this reason the index gear should be accurate and as large as possible. With an index of but four inches in diameter extraordinary precautions must be taken to cut a gear, say 14 inches diameter, especially if it has spiral teeth, as there is a constant tendency for a spiral gear to loosen on the work arbor. For this reason such work arbors should be equipped with both right- and left-hand nuts.

CUTTING DEEPER THAN NECESSARY

Another source of noisy gears is the necessity of cutting deeper than standard depth to secure the necessary backlash. It is, of course, out of the question to cut gears exactly standard and expect them to assemble and run easily on standard centers. Why not make the cutters to accommodate this backlash, say 0.005 inch wide on the pitch line per inch of circular pitch? Cutting deeper than standard is just as disastrous as using the wrong cutter. Involute teeth will

maintain proper contact as the gear centers are moved but this does not apply in that way to the cutting of the teeth. A gear has a fixed base circle upon which the involute curve must be based, if a smooth running gear is to be had. The pitch circle, on the other hand, is not necessarily fixed but will change with the gear centers as far as the theoretical action of the teeth is concerned. This fact is not generally understood.

With a standard cutter the only correct method of cutting backlash is to roll the gear the necessary amount, making a side cut after cutting the gear in the usual manner. Do not shift the cutter to obtain this result; chordal measurements are absolutely essential.

The cutter should be central and run true. The cutting edges should be cut well, otherwise, the cutter will not produce its own shape in the gear.

The work arbor must be supported so that there is no tendency for the gear to lift when held vertical or sag when in a horizontal position, producing a shallow tooth on one side.

The ways of the gear cutter must be straight to produce a flat tooth and the carriage properly gibbed to prevent its twisting and allowing the cutter to drag when entering and cut "trade marks" upon its return trip.

To produce an accurate gear the teeth should first be roughed out close to the finished side, if possible removing all stock from the bottom of the tooth. There should be ample stock on the sides, however, for a full tooth, otherwise the cutter is very liable to follow the original spacing. It is not a bad idea to take the finishing cut on a second machine; in the meantime give the gear ample time to reach its normal temperature.

Do not depend upon the bottom diameter for the proper depth of cut; take all measurements from the outside diameter, using chordal tooth parts and allow for any error in turning up the gears. An accurate method of measuring spur gears is to lay in rollers approximating the tooth thickness at the pitch line and caliper over them. For an odd number of teeth caliper from the point of the opposite tooth, allowing for any error in the measurement of the outside diameter, or from the bore to a roller placed in any one of the teeth. A description of this method of measuring appeared in the AMERICAN MACHINIST, page 1156, Volume 33, Part 1, by R. C. Thompson. This method, on account of the accompanying mathematics is not practical for everyday use but is admirably adapted to certain lines of gears, as for automobile transmissions.

For general work a good plan is to make a tool-steel master pinion for each standard pitch to be cut of sufficient width of face to take in anything that may be made. Knowing positively that these gears are exactly standard, they may be used for inspection by measuring the center distance at which they will operate freely with the gear being inspected.

ALINEMENT OF BEVEL GEARS

The alinement of bevel gears may be readily tested by a pair of tapered pins which are laid in opposite tooth spaces. The points of the pins meeting at the apex will show any distortion of the teeth. It is not necessary that these pins follow the pitch line, therefore, one pair may be used for quite a range of work.

RUNNING IN WORM GEARS

When cutting worm gears do not depend upon the throat diameter, check the normal tooth thickness. After securing the proper thickness of tooth, draw out the hob and give it a fractional turn upon its arbor, say, one-half the space between the flutes and re-hob to the original position. This is often absolutely necessary when hobbing gears which engage a multiple thread worm. For a quiet worm drive, place the worm on the hob arbor and grind the worm and the gear into contact with oil and graphite until the proper centers are obtained and the teeth have the proper contact. If the face of the worm gear is much more than 6/10 of the outside diameter of the hub, it will be rather difficult to secure a quiet drive without much grinding. This is also the case when the hob is shorter than the worm and the worm engages the wheel for its full length.

An angle of 55 degrees for the driver and 35 degrees for the follower, measured from the axes, makes a very efficient drive for worm or spiral wheels. Castor oil makes an excellent lubricant.

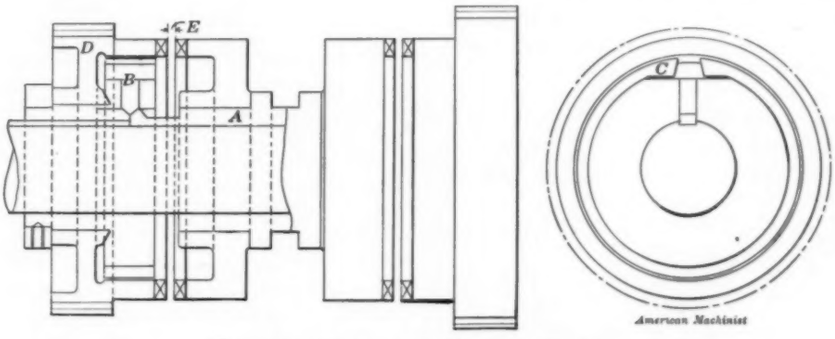
A steel gear should be properly annealed if a quiet or safe gear is required. An unannealed steel gear is liable to distort at any time, especially if subject to atmospheric changes. Such a gear will often break during the cutting of the teeth, the separation of the rim and arms, also the separations in the rim itself, showing the strain it has been under. How could such a gear be expected to remain true for any length of time? This also applies to cast-iron or bronze gears, improperly designed or set. If the cutter starts to chafe in the middle of a cut, do not replace it with another cutter until you are sure that it is not up against a streak of hard material or a hard spot in the casting which must be removed with a chisel. The second cutter is very liable to go down much quicker than the first one if such is the case, as the galled cutter has left a surface upon which it is very difficult to start a new cut. Remember that the cutter is often worth more than the gear you are cutting, especially if the charge for cutting alone is considered.

Combined Tooth and Friction Clutch

BY H. SHELDON

The difficulties and objections accruing from the shock of tooth clutches, when thrown into gear at high velocities, are numerous and evident to all engineers.

The use of friction clutches, of course, obviates many of these difficulties, but friction clutches are not positive and in designing this it was my object to obtain a tooth clutch that could be thrown into gear at a high velocity without shock. The accompanying halftone is the result and is a combination of a tooth and friction clutch, which seems to possess the positive qualities of the toothed clutch with the shockless ones of the friction type.



COMBINED TOOTH AND FRICTION CLUTCH

The sleeve *A* is slid along the shaft by the clutch lever and engages with the wedge *B;* the lower part of which is inclined at an angle of 45 degrees. The action of the sleeve sliding along the shaft the distance at *E* forces wedge *B* up and expands ring *C*. The friction of this ring causes wheel *D* to be rotated. Now if the sleeve and clutch are slid still further in gear the friction clutch is released and the positive clutch comes into action. With this arrangement the positive clutch can be thrown in with practically no shock at all as the stationary parts have been brought up to the same or nearly the same speed as the drivers before the jaws are thrown into engagement.

Effect of Keyways on Shaft Strengths*

By Herbert F. Moore †

A shaft with a single keyway of ordinary dimensions has about the same ultimate strength as a shaft without a keyway. No difference between the strength of shafts with long keyways and of similar shafts with the usual shorter keyways was observed.

The efficiency of shafts with keyways ranged from 73.5 to 85 per cent.

*Slightly condensed from *Bulletin* No. 42, University of Illinois Engineering Experiment Station.

†Assistant professor of theoretical and applied mechanics.

In the transmission of power by means of shafting and pulleys or gears, the common method of fastening the pulley or gear to the shaft, so that the two will rotate together, is by means of a key inserted in a keyway cut in the shaft, and extending into a corresponding keyway cut in the hub of the pulley or gear. The strength and the proper proportioning of keys have been subjects of considerable study and of some experimentation, but the effect of the keyway on the torsional strength of the shaft has apparently been studied but little. Evidently, the keyway must weaken the shaft in which it is cut. It would seem that the sharp corners of the keyway and its location at one side of the shaft might weaken the shaft more than the relatively small size of the keyway would lead us to expect. In view of the very extensive use of shafts with keyways and the small amount of information available on the subject, the effect of keyways on the torsional strength of shafts has seemed to me a problem worthy of some experimental study. This is an account of a brief investigation carried on in the laboratory of applied mechanics by the Engineering Experiment Station of the University of Illinois.

The mathematical analysis of the

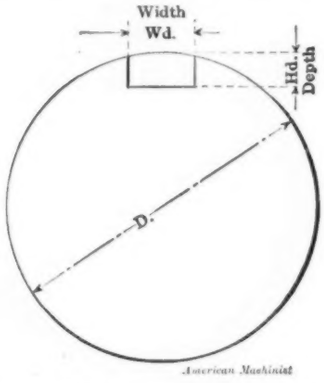


FIG. 1. KEYWAY MEASUREMENTS

strength of a shaft with a keyway cut in it is a problem of great complexity. The common theory of stresses in shafts applies only to shafts of circular cross-section. Mathematical researches by Saint Venant and others have developed the theory of square, rectangular, triangular, and elliptical shafts, but so far as I know, there has been no successful attempt to develop the mathematical theory of the stress in a shaft with a keyway cut in it. However, as the range of sizes of shafts and keys in common use is not very great, it was thought that an experimental study of the effect of keyways on the strength of shafts might lead to formulas which may be safely used in nearly all the cases met by the designer of shafts and keys.

It was found possible to investigate by direct experiment the effect of keyways on the strength of shafts of various sizes, and to study the effect of keyways on the strength of shafts subjected to combined bending and twisting.

For this use in calculation and design, it was thought best to coin a term to permit comparison between a shaft with keyway and an uncut shaft. Adopting a nomenclature similar to that used by many writers on the strength of riveted joints, the ratio of the strength of a shaft with a keyway to the strength of a similar shaft without a keyway is hereafter spoken of as *the efficiency of the shaft with keyway*.

If a shaft with a pulley keyed to it is given a permanent twist, the removal of the pulley is frequently a matter of great difficulty; while if a shaft carries a sleeve or gear with a key sliding in a keyway, any permanent twist practically ruins the shaft. For these reasons the elastic limit of a shaft under torsion is taken as the measure of its strength.

NOTATION AND FORMULAS

The following notation is used:

d = Actual diameter of shaft in inches.

w = Width of keyway ÷ diameter of shaft.

h = Depth of keyway ÷ diameter of shaft.

T = Torsional (twisting) moment on shaft in inch-pounds.

M = Bending moment on shaft in inch-pounds.

J = Polar moment of inertia of cross-section of shaft (for circular shaft, $J = \frac{d^4}{10.2}$).

f = Greatest fiber stress in shaft due to torsion.

Θ = Angle of twist of shaft in degrees.

l = Length of shaft in inches.

E_s = Modulus of elasticity of material of shaft in shear (torsion).

e = Efficiency of shaft with keyway.

k = Ratio of angle of twist of shaft with keyway to angle of twist of similar uncut shaft.

$H.P.$ = Horsepower.

$r.p.m.$ = Number of revolutions per minute.

The following formulas are use:

$$T = \frac{2fJ}{d}.$$

$$\Theta = \frac{2fl}{E_s d} \times 57.3.$$

$$T = 63{,}020 \frac{H.P.}{r.p.m.}.$$

The first two formulas are based on the following assumptions; (1) that a plane section of the shaft remains plane during torsion; and (2) that the fiber stress varies uniformly from zero at the axis of the shaft to a maximum at the outer fiber,

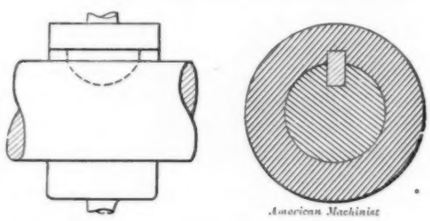


FIG. 2. OUTLINE OF WOODRUFF KEY

i.e., the modulus of elasticity for shear remains constant. The first assumption is not true for shafts which are not circular in cross-section.

TEST PIECES

The principal object of this investigation was to obtain values of the efficiency of shafts with keyways, and as nearly all shafting in common use is cold-rolled, the principal series of tests was made on specimens of cold-rolled steel shafting. The diameters of the test shafts of these series were 1¼, 1 9/16, 1 15/16 and 2¼ inches. Shafts were tested under simple torsion and under torsion combined with bending. The bending moment applied to the shaft was in one case equal to the torsional moment, and in another equal to

three-fifths the torsional moment. Table 1 shows the sizes of shafts and the sizes of the keyways cut in them.

Dia. Shaft Inches. d	Relative Dimensions of Keyway.		Actual Dimensions of Keyway Inches.	
	w	h	Width.	Depth.
$1\frac{1}{4}$	0.25	0.125	$\frac{5}{16}$	0.156
	0.50	0.125	$\frac{5}{8}$	0.156
	0.25	0.1875	$\frac{5}{16}$	0.234
$1\frac{9}{16}$	0.25	0.125	$\frac{25}{64}$	0.195
	0.50	0.125	$\frac{25}{32}$	0.195
	0.25	0.1875	$\frac{25}{64}$	0.293
$1\frac{15}{16}$	0.25	0.125	$\frac{31}{64}$	0.242
	0.50	0.125	$\frac{31}{32}$	0.242
	0.25	0.1875	$\frac{31}{64}$	0.363
$2\frac{1}{4}$	0.25	0.125	$\frac{9}{32}$	0.281
	0.50	0.125	$1\frac{1}{8}$	0.281
	0.25	0.1875	$\frac{9}{32}$	0.422

TABLE 1. DIMENSIONS OF SHAFTS AND KEYWAYS. SERIES OF 1909.

For transmitting power, it is common American practice to use a square key whose width and depth are each equal to about one-fourth the diameter of the shaft (Kent's Pocket Book, pp. 975-976). This means a keyway in the shaft in which $w = 0.25$ and $h = 0.125$. The depth of keyway is measured as shown in Fig. 1.

Shafts were also tested with keyways for the Woodruff system of keying. The outline of the Woodruff key and its keyway are shown in Fig. 2. In choosing the sizes of Woodruff keyways to be cut in the test shafts, the shearing strengths of various standard sizes of keys were figured, and a standard size was chosen such that the shearing strength of two keys equaled, as nearly as possible, the torsional strength of the solid test shaft in question. The sizes of the Woodruff keys chosen are shown in Tables 2 and 4.

In addition to the above tests for effect of single keyways on the strength of cold-rolled shafting, tests were made (principally in the 1908 series) which yielded data on the following subjects: ultimate strength of shafts with keyways; effect of two keyways at right angles; effect of length of keyway; effect of keyways on turned steel shafting.

All keyways, except in the tests for studying the effect of length of keyways, were cut to a length equal to about four times the diameter of the shaft, no keyway being longer than eight inches.

All material for the test shafts was bought in the open market. Both the cold-rolled and the turned shafting were of ordinary soft steel. All tests were planned in duplicate, and with a very few exceptions, all tests were made in duplicate.

Procedure of Tests

In the 1908 tests, which were all on shafts under twisting only, the method of conducting the test was to apply torsion continuously until the yield point was passed, frequent readings of twisting moment and of corresponding angle of twist being taken. After the yield point was passed, the twist-measuring apparatus was removed, and the torsion applied until the shaft broke, the maximum twisting moment carried being noted.

In the 1909 tests, both under simple torsion and under combined twisting and bending, the method of procedure was as follows: A small initial load was applied to the shaft, and an initial reading taken on the twist-measuring apparatus; more load was then applied and the angle of twist read; the load was then released to its initial value, and the angle of twist again read, any permanent set being thus detected; a load slightly greater than the previously applied load was then put on the shaft, and this load in turn released to the initial value. This process was repeated with applications of increasing loads until the yield point of the shaft was passed.

Ultimate Strength of Shafts with and without Keyways

Table 2 (tests of 1908) shows the results of tests to breaking of shafts with and without keyways. It seems that a shaft with a single keyway of common dimensions has about the same ultimate strength as a shaft without keyway. In the torsional tests to destruction, after the elastic limit of the shaft had been passed, the keyways gradually closed up and at rupture they were entirely closed. The larger keyways and the two keyways 90 degrees apart lowered the ultimate strength somewhat. The variation in strength due to difference in material of the shafting seems to cause more variation in ultimate strength than is caused by different keyways. As previously pointed out, the elastic limit of a shaft is more significant than its ultimate strength.

Effect of the Length of Keyway

Several special tests were made on the effect of keyways on the strength of shafts. In general, these tests, while too few in number to justify final conclusions, gave suggestive or tentative results.

The keyways in nearly all the shafts tested were cut to a total length of about four times the diameter of the shaft, no keyway being longer than 8 inches; but in several special shafts, keyways were cut 18 inches long. No difference between *strength* of shafts with long key-

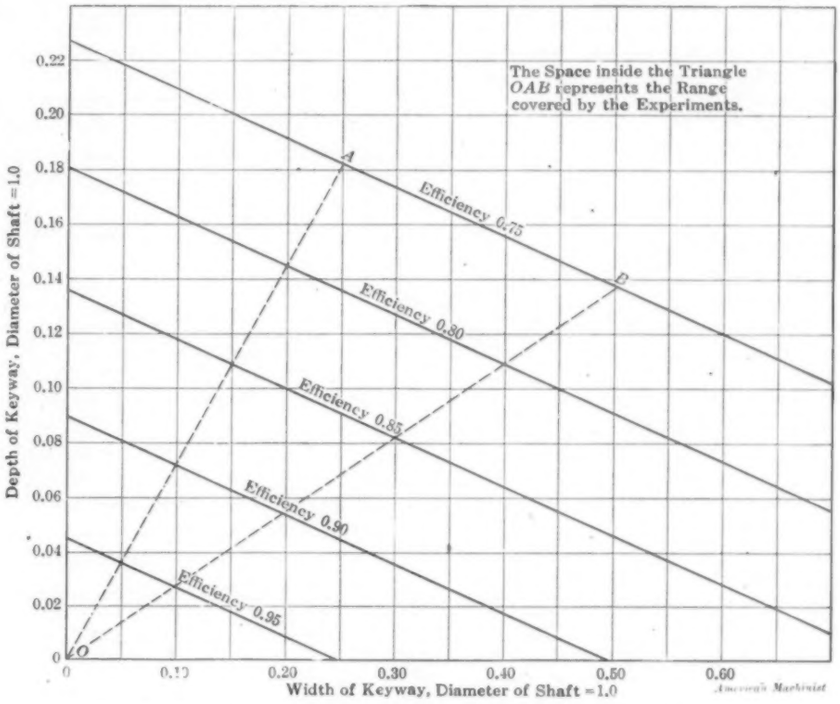


FIG. 3. CHART TO DETERMINE CROSS-SECTION OF KEYS FOR SHAFTS

ways and of similar shafts with the usual shorter keyways was observed.

Effect of Two Keyways 90 Degrees Apart

One test was made of a shaft having cut in it two keyways 90 degrees apart, the two keyways being located in the same cross-section of the shaft. While the result of this single test is by no means conclusive, it is of interest to note that the reduction in strength at elastic limit of the shaft by these two keyways was nearly three times as great as the reduction in strength at elastic limit of a similar shaft by one such keyway.

Effect of Keyways on Turned Shafting

The tests made were mainly on cold-rolled shafting, but in the 1908 series a few tests were made on test specimens

of turned shafting. Owing to the imperfect method used in the 1908 tests for locating the elastic limit, these results must be regarded as tentative. In these tests the effect of keyways on the strength of turned shafting at the elastic limit seemed to be about the same as the effect of keyways on the strength of cold-rolled shafting.

Strengthening Effect of Key in Place

During the tests, the question arose as to the difference in strength of a shaft with empty keyway and a shaft on which a pulley was keyed in place, the key nearly filling the keyway. It was judged best, however, to test shafts with empty keyways, as there is usually a part of the keyway at either end not filled by the key, and a perfect fit of the key in the keyway is by no means certain, especially after long service and, therefore, for purposes of design the empty keyway determines the strength of the shaft.

Effect of Keyway on Stiffness of Shaft

The amount of twist in a shaft transmitting power is frequently of importance. Table 3 gives the ratio of angle of twist of shafts with keyways to angle of twist of shafts without keyways as computed from the data of the torsional tests for stresse within the elastic limit. The results are fairly well represented by the equation

$$k = 1.0 + 0.4\,w + 0.7\,h,$$

in which k = ratio of angle of twist of shaft with keyway to angle of twist of similar shaft without keyway, w = width of keyway ÷ diameter of shaft, and h = depth of keyway ÷ diameter of shaft.

Keyways for two Woodruff keys of shearing strength sufficient to develop the full twisting strength of shaft seemed to reduce the stiffness of the shaft somewhat less than did a keyway for a square key whose side measures one-fourth the diameter of the shaft.

Diameter of Shaft Inches.	Dimensions of Keyway.			
	$w = 0.25$ $h = 0.125$	$w = 0.25$ $h = 0.1875$	$w = 0.50$ $h = 0.125$	Woodruff System*
1¼	1.24	1.25	1.27	1.11
1⅜	1.14 1.18	1.24 1.21	1.19 1.36	1.11 1.18
1½	1.16 1.29	1.21 1.48	1.41 1.54	1.11 1.12
2¼	1.10 1.10	1.25 1.28	1.18 1.37	1.05 1.10
Average	0.17	1.27	1.33	1.11

*See Table 4 for sizes of Woodruff Keyways.

TABLE 3. RATIO OF ANGLE OF TWIST OF SHAFT WITH KEYWAY TO ANGLE OF TWIST OF SIMILAR SHAFT WITHOUT KEYWAY.

Diameter of Shaft Inches.	Keyway. Width Inches.	Keyway. Depth Inches.	Maximum Twisting Moment in.—lb.	Maximum Computed Fiber Stress (solid shaft) lb. per sq. in.	H. P. 100 r.p.m.	Remarks.
1¼ in. cold-rolled.	0	0	27,400	70,550	43.4	Shaft without keyway.
	1/4	1/4	27,600	71,000	43.8	
	5/16	5/16	30,000	78,000	48.0	
	3/8	3/8	24,400	63,000	38.7	
	1/4	1/4	27,600	71,000	43.8	
	1/2	1/2	27,200	70,000	43.1	
	No. 10	No. 10	25,500	65,800	40.4	Keyway for No. 10 Woodruff.
	No. 15	No. 15	26,200	67,600	41.6	Keyway for No. 15 Woodruff.
	1/4	1/4	25,300	65,200	40.1	2 keyways 90° apart.
1¼ in. turned.	0	0	25,300	65,200	40.1	Shaft without keyway.
	1/4	1/4	25,800	66,400	40.9	
	1/4	1/4	25,500	65,700	40.4	
	No. 10	No. 10	23,700	61,000	37.6	Keyway for No. 10 Woodruff.
	No. 15	No. 15	24,100	62,100	38.2	Keyway for No. 15 Woodruff.
1⅜ in. cold-rolled.	0	0	54,700	65,000	86.8	Shaft without keyway.
	11/64	11/64	56,400	67,000	89.6	
2 in. cold-rolled.	0	0	103,700	66 000	164.5	Shaft without keyway.
	1/8	1/16	102,100	65,000	162.0	
	1/8	1/16	101,500	64,600	161.1	
	1/8	1/16	94,200	60,000	149.1	
	1/8	1/16	104,500	66,500	165.7	
	No. 16	No. 16	105,300	67,000	167.0	Keyway for No. 16 Woodruff.
	No. 21	No. 21	100 500	64,000	158.7	Keyway for No. 21 Woodruff.
2 in. turned.	0	0	100,500	64,000	158.7	Shaft without keyway.
	1/8	1/16	94,200	60,000	149.1	
	1/8	1/16	94,200	60,000	149.1	
	No. 16	No. 16	89,800	57,200	142.5	Keyway for No 16 Woodruff.
	No. 21	No. 21	85 000	54,100	134.8	Keyway for No. 21 Woodruff.

TABLE 2. ULTIMATE STRENGTH OF SHAFTS WITH KEYWAYS AND WITHOUT KEYWAYS.
Values are the Average Results of Two Tests.

In considering the torsional stiffness of a shaft, it must be remembered that the keyways reduce the stiffness only over that portion of length which they actually occupy.

Efficiency of Shafts with Keyways

The efficiency of a shaft with keyway has already been defined as the ratio of strength at elastic limit of a shaft with keyway to the strength at elastic limit of a similar shaft without keyway.

The determination of the elastic limit of a shaft under torsion is somewhat difficult; when the outer fibers are stressed to the elastic limit, the stress is taken more largely by the inner fibers, and the change of angle of twist is not so sudden as is the change of stretch at the elastic limit in a piece under tension, where the fibers are stressed nearly uniformly, and all begin to yield at nearly the same time. In the 1908 tests, each test shaft carried only a single keyway, and comparison between the strength of shafts with keyways and the strength of similar shafts without keyways was made by testing different specimens. This allowed a comparison of the ultimate strengths, which are very clearly defined; but in comparing elastic limits, the variation between the material of different specimens was sufficiently great to throw some doubt on the accuracy of the efficiency of shafts with keyways, as determined by this method. In the 1909 tests, the elastic limit of a section of shaft with keyway was compared with that of an adjacent section without keyway in the same shaft. Thus the error due to difference in material was greatly reduced, but by this method the ultimate strength of only the weakest section of the shaft could be obtained. So while all the results on ultimate strength have been obtained from the 1908 tests, the efficiencies of the shafts with keyways have been obtained entirely from the 1909 tests.

Table 4 shows the efficiency of the various test shafts of the 1909 series of tests, using the term efficiency as previously defined. From this table it would appear that for a set of shafts of different sizes having the dimensions of the keyway kept proportional to the diameter of shaft, the efficiency does not depend, in any noticeable degree, on the size of shaft. The efficiency does not seem to be affected by the addition of a bending moment as great as the twisting moment. The efficiency of a shaft with two keyways cut in the same plane for two Woodruff keys, of such size that the strength of solid shaft was equal to the shearing strength of the two Woodruff keys, is about the same as the efficiency of a shaft with a keyway whose width equals one-fourth the diameter of the shaft and whose depth equals one-eighth the diameter of the shaft.

The results of the foregoing tests are fairly well represented by the equation

$$e = 1.0 - 0.2\,w - 1.1\,h$$

in which

e = Efficiency of shaft with keyway,
w = Width of keyway ÷ diameter of shaft,
h = Depth of keyway ÷ diameter of shaft.

This equation gives efficiencies slightly lower than those observed for keyways of small width or depth, and efficiencies about the same as those observed for

keyways in which $w = 0.50$ and $h = 0.125$; or $w = 0.25$ and $h = 0.1875$. As this equation is entirely dependent on the results of experiments, it should not be used for points much outside the limits of the experiments. The limits of the above series of tests were keyways having $w = 0.50$ and $h = 0.1875$.

Fig. 3 affords a convenient graphical method of applying the above formula, and is used as follows: To determine the efficiency of a shaft with a given (or proposed) keyway, locate on the diagram a point whose vertical distance from 0 equals the value of h, and whose horizontal distance from 0 equals the value of w. This point will, in general, fall between two lines representing values of efficiency, and the efficiency of the shaft in question may then be estimated with sufficient accuracy. The space within the triangle OAB represents the range covered by the tests actually performed, and covers the proportions of keyways commonly used in practice.

Torsional Strength of Shafts with Keyways

The object of these tests was to determine ratios of strength and stiffness between shafts with keyways and shafts without keyways. The number of tests was not sufficient to give very much information as to the properties of cold-rolled steel shafting. However, as a matter of general interest, the values found in these tests for the modulus of elasticity in shear (torsion), and of the fiber stress at the elastic limit of the cold-rolled test shafts at sections without keyway, have been tabulated in Tables 5 and 6.

Taking the fiber stress at the elastic limit of cold-rolled steel shafting at 37,500 pounds per square inch (a value slightly less than the average found in the tests), and the efficiency of shafts with keyways from the equation $e = 1.0 - 0.2\,w - 1.1\,h$, values for the twisting moments and the horsepower at 100 revolutions per minute, transmitted by cold-rolled shafts stress to the elastic limit, have been computed for various sizes and tabulated in Table 7.

Dimensions of Keyway.	$w = 0.50$ $h = 0.125$	$w = 0.25$ $h = 0.1875$	$w = 0.25$ $h = 0.125$	Woodruff System*
Under simple torsion:				
Cold-rolled shaft, diameter 1¼ inches	0.762	0.760	0.820	0.840
Cold-rolled shaft, diameter 1 5/16 inches	0.803	0.846	0.900	0.860
	0.758	0.817	0.889	0.815
Cold-rolled shaft, diameter 1 7/16 inches	0.748	0.710	0.860	0.826
	0.764	0.750	0.824	0.835
Cold-rolled shaft, diameter 2½ inches	0.848	0.775	0.839	0.943
	0.705	0.689	0.825	0.861
Under combined torsion and bending:				
1. Twisting moment = Bending moment	0.630	0.636	0.791	0.716
Cold-rolled shaft, diameter 1¼ inches	0.680	0.698	0.803	0.750
Cold-rolled shaft, diameter 1 7/16 inches	0.584	0.697	0.854	0.858
	0.671	0.775	.....	0.840
2. Twisting moment = ½ Bending moment				
Cold-rolled shaft, diameter 1¼ inches	0.895	0.670	0.940	0.930
	0.870	0.735	0.888	0.880
Cold-rolled shaft, diameter 1 7/16 inches	0.740	.....	0.832	0.856
	0.815	.....	0.840	0.810
General Average	0.752	0.735	0.850	0.845

*In 1¼-inch shafts keyways were cut for No. 15 Woodruff keys.
1 5/16-inch shafts keyways were cut for No. 25 Woodruff keys.
1 7/16-inch shafts keyways were cut for No. 8 Woodruff keys.
2½-inch shafts keyways were cut for No. U Woodruff keys.

TABLE 4. EFFICIENCY OF SHAFTS WITH KEYWAYS.

$$\left\{ \text{Efficiency} = \frac{\text{elastic strength of shaft with keyway}}{\text{elastic strength of shaft without keyway}} \right\}$$

Test No.	Diameter of Shaft, Inches.	Modulus of Elasticity.
46	1¼	12,900,000
47	1 5/16	12,000,000
48	1 7/16	12,490,000
49	1 15/16	10,800,000
50	1 15/16	12,660,000
51	2¼	11,340,000
52	2¼	11,710,000
	Average	11,985,000

TABLE 5. MODULUS OF ELASTICITY IN SHEAR (TORSION) OF COLD-ROLLED STEEL SHAFTING.

Test No.	Diameter of Shaft, Inches.	Fiber Stress, lb. per sq.in.
46	1¼	43,300
47	1 5/16	36,800
48	1 7/16	38,500
49	1 15/16	36,800
50	1 15/16	40,500
51	2¼	36,200
52	2¼	40,500
	Average	38,940

TABLE 6. ELASTIC LIMIT IN TORSION OF COLD-ROLLED STEEL SHAFTING.

Diameter of Shaft, Inches.	Side of Key, Inches.	Twisting Moment, in.-lb.	Horse-power at 100 r.p.m.
1	1/4	5,980	9.5
1 1/16	5/16	7,080	11.2
1 1/8	5/16	8,510	13.5
1 3/16	3/8	9,980	15.7
1 1/4	3/8	11,680	18.5
1 5/16	3/8	13,390	21.3
1 3/8	3/8	15,550	24.7
1 7/16	1/2	17,590	27.9
1 1/2	1/2	20,190	32.0
1 9/16	1/2	22,600	35.9
1 5/8	1/2	25,660	40.7
1 11/16	5/8	28,500	45.2
1 3/4	5/8	32,060	50.9
1 13/16	5/8	35,350	56.1
1 7/8	5/8	39,420	62.6
1 15/16	3/4	43,180	68.5
2	3/4	47,860	75.9
2 1/16	3/4	52,140	82.7
2 1/8	3/4	57,900	91.1
2 3/16	7/8	62,210	98.7
2 1/4	7/8	68,160	108.2
2 5/16	7/8	73,490	116.6
2 3/8	7/8	80,120	127.1
2 7/16	7/8	86,080	136.6
2 1/2	7/8	93,470	148.3

TABLE 7. STRENGTH OF SHAFTS WITH KEYWAY.

The table gives the calculated twisting moment and horse-power at 100 r.p.m., transmitted in torsion by cold-rolled shafting with keyway when stressed to the elastic limit. Fiber stress is assumed at 37,500 lb. per sq.in. The keyway is cut for a square key whose side measures approximately one-fourth the diameter of the shaft. No allowance is made for bending action. In applying this table, a suitable factor of safety should be used.

The Floor vs. a Rack

It may seem that nothing can be easier, simpler, or less expensive than the operation of dropping a piece of work on the floor or into a box after a certain machining operation has been finished on it. However, this is so far from being a fact that one of the important results of motion study lies in the reduction of time required to handle the work between one operation and its successor.

As far as the getting rid of the piece after an operation has been finished is concerned, probably nothing is less expensive in time than simply dropping it, but what about the succeeding operation? If the parts are of such a nature that they tend to tangle when thrown in a careless pile, time must be spent not only to pick them from the floor, but to entangle them from their neighbors, and then shift them in the hands into a position from which they can enter the holding devices. On the contrary, the advantages arising from putting pieces onto racks or stands, or other carrying devices, are two-fold. They are easily transported from one machine to another, and are in exactly the right location, so that the operator can grasp them with a minimum amount of time. The attendant advantage of protecting the parts from injury is important for some kinds of work.

We have pointed out that the saving in time between using a fast machine and a slow machine is not all that is needed when we begin systematically to reduce the time of manufacture. The accompanying losses are often much greater than the loss during the cutting operation. Here is one of the places where savings can be made, by providing suitable means for holding the work so that it is ready for succeeding operations. Use racks instead of the floor.

The wire-rod statistics for 1909 show almost a trebling of the output of wire products in the United States in ten years. In 1900, 846,291 gross tons were produced, while in 909 the industry reached a production of 2,335,685 gross tons.

The Field for Grinding*

By C. H. Norton †

It is doubtful if many engineers have a proper conception of the field of grinding metal.

Grinding is a manufacturing operation, permitting us to produce certain classes of work cheaper, faster and better than by any other method.

We need a more careful study of the combination of lathe work and grinding to obtain maximum production.

Grinding in various forms has been known to man from the very beginning of history, yet it is doubtful if many engineers have a clear conception of the field for metal grinding. Experience (as a specialist) covering 25 years has taught me that the usual thought of grinding is that it is a slow, tedious, expensive, but sure method of obtaining accuracy, and that where great accuracy is not required grinding should not be done.

Webster defines abrasion as "the act of wearing or rubbing off; the wearing away by friction, as the abrasion of coins." Abrade, "to waste or wear away by friction, as to abrade rocks." He defines the word abraise as "rubbed smooth, as an abraised table," meaning a polished table. No doubt here is the connection between polishing and abrasion.

Some time within the last 75 to 100 years men discovered that a revolving polishing wheel enabled them to abrade work in such a comparatively short time that so far as polishing was concerned it was no longer slow nor tedious. But as the original word for abrasive action was "grind," and grinding was slow, men still clung to the tradition in spite of the later discovery that polishing could be done quickly. When, within my recollection, mechanics made their own solid glue and emery wheels with which to grind small hardened tool work, it did not occur to them that they could do by grinding a certain part of the work that they were using steel tools for, because it was grinding, and was slow. Moreover, all nice work must of necessity take lots of time, because our older mechanics had said so. It did not occur to them that we could ever have better grinding wheels and better machines in which to use them.

It was at this point in our reasoning that the majority of engineers rested and it is here that we find a large number now. All engineers admit the exactness of grinding, but most of them still believe it to be slow.

"Appleton's Cyclopædia of Applied Mechanics," published as late as 1893, says that emery wheels are employed mainly for producing cutting edges and for smoothing surfaces. Again it says that in all cases of the employment of emery wheels in place of steel cutting tools, the operation is considerably slower, and it may be laid down as a rule that save upon metal too hard to be operated upon with steel tools, the emery wheel cannot compete with the ordinary lathe, planer, milling tool, etc. My observations convince me that a great many American engineers hold the same views.

As a specialist for many years, I have seen a gradual but sure increase of knowledge of grinding and have noted the widening of the field as the result, but I am not aware that the intelligent study of grinding has been taken up by professional engineers or by any institute of technology. The intelligent use of grinding yields such large returns that it warrants careful study by the very best engineering and scientific minds and a place in the courses of our technical schools. The field is constantly broadening with each year's improvements in grinding wheels and grinding machines, and it is time that men of brains and education took a hand with us to help the world to a better knowledge of the science of grinding and grinding wheels.

The results thus far attained warrant a change of the world's idea of grinding and instead of using it as a synonym for slowness, tedious and drudgery, it should be a synonym for rapidity, accuracy and economy.

The fact about grinding with the modern grinding machine and grinding wheel (not emery wheel) is that it enables us to size all round work cheaper than by turning and filing, that it takes the place of what we formerly called the finish cut of the lathe and all filing giving us not a theoretically perfect cylinder or perfect finish, but a much nearer perfect cylinder and finish that we obtained with the lathe. It gives us diameters to such small limits as to be called exact, but whoever insists that none but exact work be ground loses the very pith of grinding, which is economy. Modern grinding means cheaper cost for all work, many grades of work to suit many requirements, and cheaper turning than is possible without the use of the grinding machine.

Turning Before Grinding

As a rule, the coarser the turning the greater the economy by grinding. The greatest economy is obtained by the combination of cheaper turning and grinding. It is no longer necessary to turn work smooth, straight or correctly to size and the lathe is no longer necessary as a precision tool. If it has a carriage traverse of from four to ten threads per inch, has sufficient power to carry high-speed tool cuts at that feed and is well supplied with steady rests to prevent springing of the work, it is ready for coöperation with the grinding machine. It is easier with modern grinding machines and wheels to grind off a given amount of metal when in the form of crude screw threads than in any other form, and with long work having several sizes the grinding requires less time if 1/32 inch to 5/64 inch is left on the diameter for grinding than if the work is turned carefully to within 0.002 inch to 0.005 inch. In all cases, accurate turning increases the total cost of production and in some it makes the grinding very expensive.

The greatest economy is usually obtained by the combination of grinding with very rough turning. Yet there are cases where the least expensive way is to grind direct without turning, notably the greater part of crankshafts of automobiles and small gas engines and very long and slender work where turning is difficult.

It is not an easy matter to secure such rough turning as true economy requires in connection with grinding. Lack of knowledge of what is needed, coupled with the natural pride the workman takes in doing what tradition says is nice lathe work, prevents the grinding machine from doing what it is ready to do. Our industries are losing much while waiting

*Slightly condensed from paper presented to the American Society of Mechanical Engineers.

†With the Norton Grinding Company, Worcester, Mass.

FIG. 1 First Two Stages in the Grinding of an Automobile Cam.

FIG. 2

FIG. 3 Last Two Stages in the Grinding of an Automobile Cam

FIG. 4

FIG. 5 Double Cam Ground from Rough Stock 2 Inches in Diameter.
American Machinist

for the engineer to assume the intelligent guidance of foreman and workmen who, through fear, doubt or prejudice now rob us of the great economies due to modern grinding machines. There is much yet to be learned by foremen and workmen about turning. High-speed steel makes possible much that has not as yet become common knowledge.

The lathe is a very old tool and foremen and workmen have known it for generations, yet I have been unable to find more than two instances where a careful study has been made of the combination of lathe work and grinding to effect the maximum saving. I have observed that lathe men have not tried to remove metal by increasing the number of cuts and using fast traverse. When urged to take coarse feeds to help the grinding machine to effect a total saving, they have invariably said that they were feeding all that the work would stand.

It has been demonstrated that three cuts with a carriage traverse of 6 per inch has produced certain work in 9 minutes that required 13 minutes to turn in one cut, because the work was so frail that with one cut no faster feed than 32 per inch could be taken. The rough-ridged surface was readily ground by taking 1 minute more than when the turning was finer, the net saving for the job being 3 minutes. In many cases the ridged surface requires no additional time.

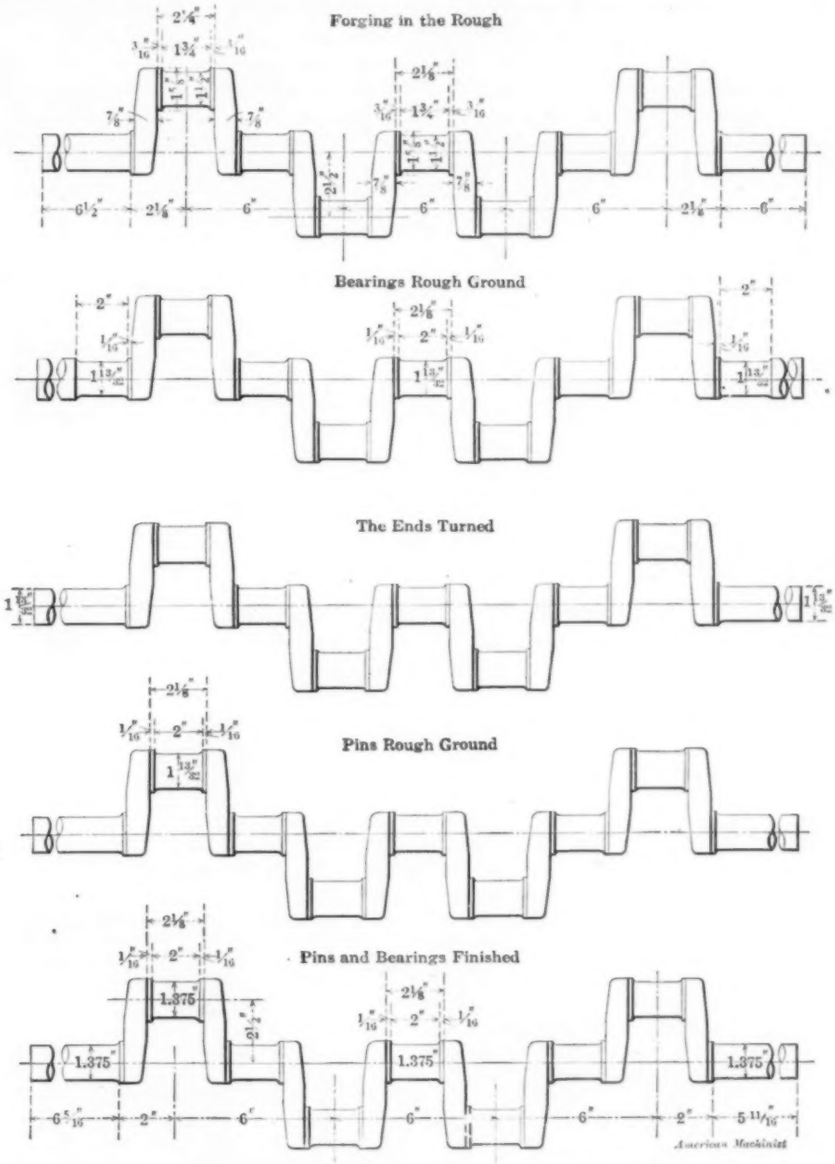


FIG. 6. STAGES IN THE GRINDING OF AN AUTOMOBILE CRANK SHAFT

In another case where the work was quite firm and was being revolved at a very high speed with a view to getting everything possible from the high-speed tool, the turning required 5 minutes and the grinding 1 minute. A change was made in the feed of the lathe so that without revolving the work any slower it was turned in 1 minute, leaving a very crude, crooked and bad-looking piece of lathe work. The grinding then required 2 minutes, but the net time saved was 3 minutes. Did it matter how bad a looking lathe job it was if the finished work was perfect and 3 minutes was saved?

There is a rich field for engineers and managers in connection with the lathe and modern grinding. Recent lathe designs provide for high speed of revolution, with sufficient power, quick change to and from back gears, and sufficient rigidity to utilize to the limit high-speed steel; but much work is not of sufficient rigidity to permit the maximum use of the tool at fast traverse and deep cuts. In addition, there are thousands of lathes of old design that will not be thrown away at once. There is, therefore, an opportunity to get much more out of present plants by cheaper turning, *because of grinding.*

Developments warrant the conclusion that we should no longer assume that simply because a tool is a grinding wheel it cannot remove metal and size and shape work as quickly as a steel tool. Rather, we should use the steel tool when it can be made to remove metal, size and shape work cheapest, and the grinding wheel when it excels. It is no longer to be taken as a matter of course that we can turn, plane and mill faster than we can grind. After all, the real reason we remove metal is to accomplish certain finished results, not simply to secure a certain number of pounds of chips in a given time. Before long I think all progressive engineers will understand that both the grinding wheel and the steel tool have their place for metal cutting. The old thought of abrasion must give way to the new thought of cutting.

While it is still true that poor wheels or good wheels poorly selected and wrongly used will still remove metal very slowly by abrasion, it is also true that the old-fashioned milling cutter, with fine teeth cut by hand with a file, hardened but never ground, and used in the old-time slender milling machine would very slowly abrade the surface. The modern grinding wheel, used in a modern machine by a modern man, is just as surely a milling cutter as if it were made of steel.

The microscope reveals the fact that such a wheel cuts off chips.

The grinding wheel as now made is really a milling cutter with millions of cutting teeth. Although these teeth are not as large or as strong as the teeth of a steel cutter and, therefore, cannot cut as deeply, yet they are capable of cutting at much greater speed. Since there are so many more of them they are capable of much more work in a given time when the nature of the work is such that a large number of these cutting points can be used simultaneously. In some cases we can use as many as two billion cutting points per minute. Eight hundred million per minute is not uncommon and four hundred million per minute is very common.

The modern grinding wheel, mounted in a good machine, can be used at a cutting speed of 6000 or more surface feet per minute and owing to this high speed it need not cut deeply relative to the rigidity of the work. Therefore it is able to remove metal from many forms of work more quickly than the milling cutter or the lathe tool.

An Illustration—Grinding Automobile Cams

The accompanying illustrations show a notable example. Figs. 1 to 4 inclusive, show the process of making automobile cams. An order for a hundred of these cams was received and our shop superintendent began to provide means for producing them at the lowest possible cost. It is evident that drop forgings for so few would be out of the question, as the expense of dies would make the cost of the cams prohibitive. It was, therefore, necessary to devise means for producing them from the bar stock. This was done by providing an eccentric chuck for the automatic screw machine. To prevent the bar from turning in the chuck while feeding forward, the spline was made the full length and a mating key was placed in the chuck. Pieces like Fig. 1 were made in the automatic machine at the rate of 10 per hour. A keyway in the hole was made in the ordinary way, Fig. 2. These blanks were ground to rough shape, Fig. 3, at the rate of 10 per hour. The cams were then hardened and finished ground to Fig. 4 at the rate of 40 per hour. It should be clear that such a cam could not be milled to shape from the blank in nearly so short a time with the milling cutter. When manufacturing such cams in large numbers drop forgings would be used, and here again the grinding wheel is quicker than the milling cutter.

Grinding Pins and Bearings of Automobile Crankshafts

Another case where the grinding machine can accomplish the results desired in less time than the lathe is that of the pins and bearings of the automobile crankshaft. The results desired are as follows: Five bearings, all round within 0.00025 inch; the axis of all parallel and exactly in line; all of the right length within 0.004 inch; distance between bearings within 0.004 inch; accumulated error not over 0.008 inch. Four crank pins, all round within 0.00025 inch; the axis of all exactly parallel; all to length within 0.004 inch; all parallel with the bearings; all within 0.005 inch of the same plane; all of correct throw, within 0.010 inch; overall length, accumulated error not over 0.008 inch; all fillets correct radius and exactly concentric with the bearings and pins; all bearings and pins straight within 0.00025 inch; and all a good, smooth surface.

In the case of cranks designed with clearance for the arms of the cranks, as shown in Fig. 6, the width of the wheel is identical with the required length of the pins and bearings, so that no measuring

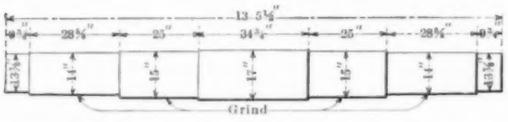


Fig. 7. Engine Shaft—Hammered Forging.
Weight, 8000 Pounds; Stock Removed, 0.025 Inch; Limit, 0.001 Inch; Time, 6 Hours (8 Hours including Handling.)

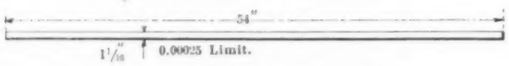


Fig. 8. Shaft 0.30 Carbon Steel.
Stock Removed, 1/16 Inch; Limit, as noted; Time, 1 Hour (including Setting Up.)

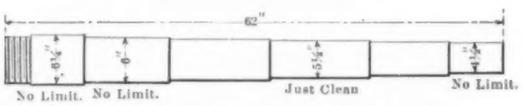


Fig. 9. Lathe Spindle—Crucible Steel, Hardened.
Stock Removed, 0.035 Inch; Limits, as noted; Time, 1½ Pieces per Hour.

Fig. 10. Piston Pin—0.15 Carbon Steel, Hardened.
Stock Removed, 0.015 Inch; Limit, 0.0005 Inch; Time, 60 Pieces per Hour.

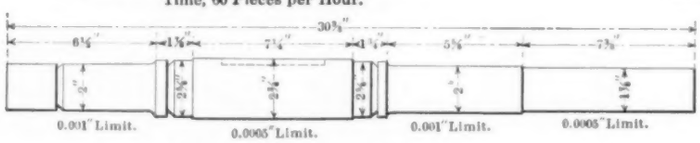


Fig. 11 Armature Shaft—0 30 Carbon Steel.
Stock Removed, 3/64 Inch; Limits, as noted; Time, 3 Pieces per Hour.

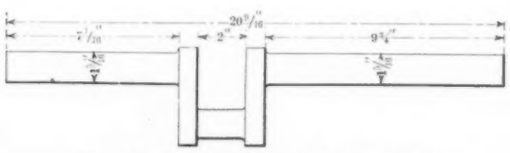


Fig. 12. Crankshaft—0.45 Carbon Steel.
Grind Bearings only; Stock Removed, 0.015 Inch; Limit, 0.0005 Inch; Time, 50 in 7 Hours, 15 Minutes.

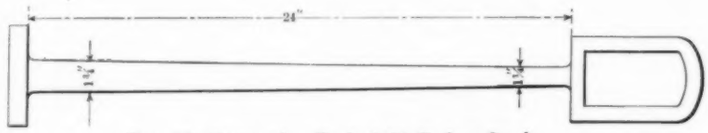


Fig. 13. Connecting Rod—0.30 Carbon Steel.
Stock Removed, 0.008 Inch; Limit, Just Cleaned; Time, 25 Pieces per Hour.

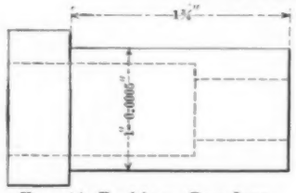


Fig. 14. Bushing—Cast Iron
Stock Removed, 0.010 Inch; Limit, as noted; Time, 45 Pieces per Hour.

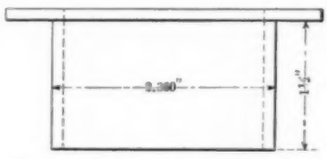


Fig. 15. Bushing—Pressed Steel.
Stock Removed, 0.025 Inch; Limit, 0.0005 Inch; Time, 60 Pieces per Hour.

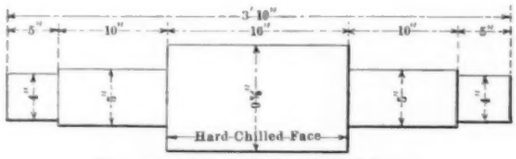


Fig. 16. Chilled Roll—Chilled Iron.
Stock Removed, 3/8 Inch; Time, Roll Face, 2½ Hours; Previous Lathe Time, 12 Hours.

Fig. 17. Chilled Roll—Chilled Iron.
Stock Removed, ½ Inch; Time, Roll Face, 7 Hours; Journals and Ends. 3½ Hours; Total, 10½ Hours; Lathe Time for same Work, 23 Hours.

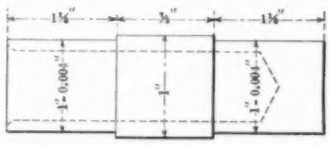


Fig. 18. Piston Pin—Machine Steel, Hardened.
Stock Removed, 0.015 Inch; Limit, 0.0005 Inch; Time, 25 Pieces per Hour. *American Machinist*

or setting of the tool is necessary for cutting to length. The act of grinding cuts the bearing or pin the right length and forms the fillets. The location of the pins and bearings within the small limits allowed is accompanied by a massive index bar, so that the workman does no measuring whatever for location of bearings or pins. The entire time of handling and producing these five bearings and four pins from the rough forging to the nicely sized and finished condition is 85 minutes. It is clear that when all the conditions of the finished work are considered the grinding wheel and machine have removed metal faster than the lathe. Again, it is not simply a case of removing pounds of metal per hour, but the removal of it in such a manner as to accomplish certain results in the least time.

The ends of these shafts beyond the bearings are turned before grinding. The entire list of operations to make a finished shaft from the forging is as follows:

	Minutes.
Cut off ends and center	6
Rough grind bearings	15
Turn ends	8
Rough grind pins	20
Finish grind pins	20
Finish grind bearings and ends	25
Square ends	6
Total time	100

A little time could be saved if it were practical to secure forgings with pins and bearings 1⅝ inches in diameter over their entire length instead of with the depression to 1½ inches between shoulders, as the wheel can be forced more rapidly when the face has the same amount of work to do as the fillets. Here again tradition is strong and difficult to change at once, because the depression is better for those who turn the work. A little cooperation would save on dies and time in grinding.

Other Illustrations

There are hundreds of other cases where the grinding wheel is used to remove metal in a more economical manner than with steel-cutting tools, some of which are shown in Figs. 7 to 18 inclusive.

Automatic grinding is a late development in the field. Certain work of which large numbers of pieces are made is ground by wholly automatic means. The work is conveyed to the machine by gravity in a hopper or chute and is chucked, ground and delivered to the receptacle. In a case where formerly, at piece work, 300 per day were ground, the automatic machine grinds 4 in a single minute, about 2300 per day.

When the knowledge of grinding becomes more common and the opposition to increased production on the part of the workmen shall have been more nearly overcome, the field will be still more extended. It is worthy of more systematic coöperation and if we get together we will be rewarded with success. The engineer is the one who by education and training is best fitted to take up the important question of the field for grinding.

Concrete in Machine Construction

By H. L. Whittemore

An example of a machine pedestal and work bench made of reinforced concrete. Suggestions for other machine parts made of same material with possible advantages from its use.

It may be that the only reason the metals, such as iron or steel, are ordinarily used in machine construction, is not that they alone are suitable but that other possible materials have not recieved sufficient consideration.

No one doubts that where maximum strength and wearing qualities are required, the metals are supreme, but there are many places for which concrete possesses all the strength required if the work is carefully designed in accordance with the principles of modern reinforced-concrete construction. The fact that machine parts require much less material would make it feasible to use the highest grade of reinforcement and a concrete mixture very rich in cement, impracticable in building construction.

Making a Concrete Machine Pedestal

When it became necessary to provide supports for several machines of the general class shown in Fig. 1, wood or iron benches were considered but concrete pedestals, as shown, were finally made for the purpose.

The reinforcing framework is shown in Fig. 3. "Ferroinclave," which is a sheet steel, formed to a dovetail cross-section, was cut and bent to the required shape and riveted together along all seams. This material costs about 10 cents per square foot. No attempt was made to secure a good appearance of this framework, simply one which was reasonably close to size and strongly fastened at the seams, as the strength of the completed pedestal depends largely upon this part of the work.

The entire framework was covered or "plastered" with portland-cement mortar inside and out, to a depth of at least half an inch over the tops of the dovetails. The proportions were about one of cement to two of sand. The inside was done first with the framework placed upside down upon the floor. The vertical sides caused some trouble due to failure of the mortar to adhere to the sheet metal even with the dovetails horizontal, which is the most favorable position. After some practice and experimenting with more or less water in the mortar the proper consistency was secured and satisfactory results obtained. If the thickness of the mortar was too great, it pulled off the framework by its own weight.

The inside was allowed to set and harden for a day or two, during which it was sprinkled or covered with a damp cloth.

For the outside, a rough framework, or mold, the size and thickness of the top slab was laid on the floor over a

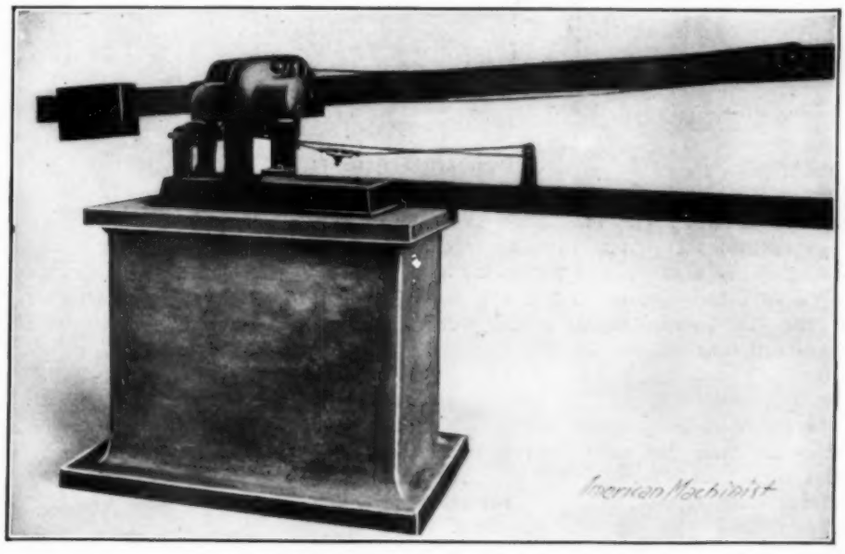


Fig. 1. Machine Set on a Concrete Pedestal

sheet of building paper. This was then filled with mortar and the top of the pedestal worked down into it the required depth. Mortar was then plastered up onto the sides for several inches and a wood cylinder, the proper diameter, used in shaping the fillet just below the top slab. After the top had set, the same method was used in forming the base slab. A rough framework or core was used to form the opening into the inside.

After completing the top and base, it was comparatively easy to cover the sides and bring them flush with the fillets top and bottom. To obtain a good bond or joint in the concrete the work should be carried on as continuously as possible.

Three of these pedestals were made and have given satisfactory service for the past three or four years in the materials-testing laboratory of the University of Illinois. At times it has been necessary to move them, this their comparatively light weight makes possible without undue exertion. The thorough reinforcing has prevented any noticeable damage due to handling, even around the base where the stresses are the greatest. They preserve their appearance much like cast-iron pedestals, which, in fact, they would closely resemble, if filled and painted in the same way. If they had been cast, all at one time, in accurate sheet metal-lined molds, they would have been much more perfect than an iron casting could ever be and the strength would have been greater than it now is, due to their being made of a very wet mixture of concrete.

supports with ample lap where sheets meet. A light strip of wood along the front edge of the bench would form a mold to retain the concrete, but the reinforcing metal is designed to retain the fresh concrete on its upper surface, so that forms for the lower surface of the top are unnecessary. A rod anchored by wires is shown to reinforce the upper edge. The upper surface of such a bench could be finished like a concrete sidewalk and the under side given a thin coating of cement or other plaster to secure a smooth surface.

FIG. 2. CONCRETE MACHINE PEDESTAL

Such a bench would be fireproof and everlasting. While it could easily be built strong enough for all ordinary requirements, its resilience would be low, so that impacts such as hammer blows would be very likely to crack and gradually disintegrate it. This could be partially prevented by adding an elastic top, such as the ordinary floor covering known as linoleum. Commercial fish glue, spread thickly over the whole surface has been used successfully for fastening such material to concrete floors in offices, etc.

Cast-iron bench legs and shop-bench drawers, both of which can be readily purchased, would greatly simplify the construction of such a bench, which would then only require the placing of the sheets of metal and covering them to the required depth with concrete.

A CONCRETE WORK BENCH

In Fig. 4 is shown a work bench in which the same general method of construction is used. The legs may be molded separately, then set in place. The top is reinforced with "Hy-rib sheathing," whose cost is about one-third that of "Ferroinclave." This is laid upon the

OTHER SUGGESTED USES

While the uses just described for concrete can hardly be considered machine construction, it is not unlikely that in the future, the operating portion of the smaller machine tools will be made, as usual, of metal but that the pedestal or cupboard base (having a door and shelves within if desired) will be of specially designed and prepared concrete. A glance through the advertising pages of this number of the AMERICAN MACHINIST will show illustrations of many small drill presses, tool and other grinders and hand-milling machines which might advantageously have such bases or frames.

A very real objection to such construction, at least from the salesman's point of view, would be the feeling of customers that such a machine was a makeshift. Perhaps as good a way as any to overcome this difficulty, would be to offer the machine with either a cast-iron or concrete base as ordered, with, of course, a correspondingly lower price for the rational design.

A low-priced column, much used at present in building construction, consists of a steel tube the required diameter and length, filled with concrete. Many of these, carefully filled with a rich concrete mixture, show remarkable results when tested to failure under compressive loads. It would seem that the same method could be used to stiffen radial-drill columns or lathe beds, etc., to resist tor-

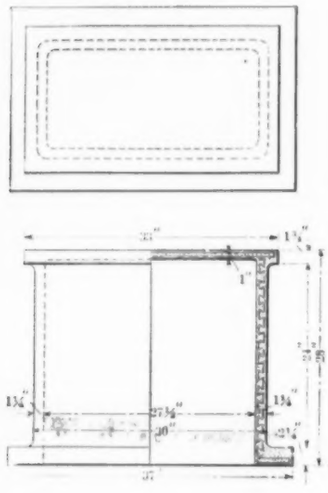


FIG. 3. DETAIL OF CONCRETE MACHINE PEDESTAL

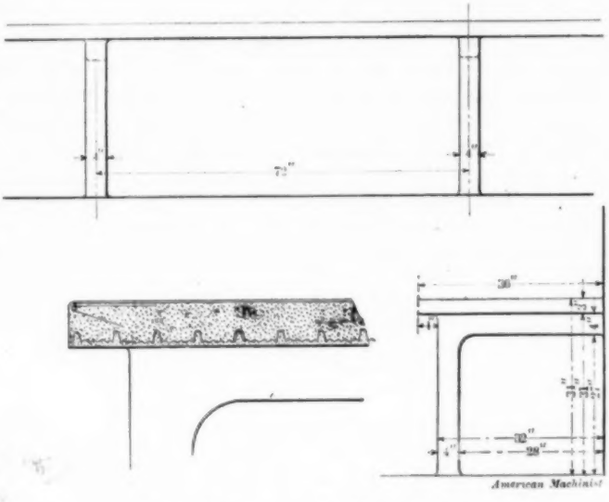


FIG. 4. DETAIL OF CONCRETE WORK BENCH

sional and bending stresses. Trial might show that while the ultimate strength of such a combination structure was raised considerably, that the stiffness was scarcely affected. As the latter is the principal consideration in machine tools actual tests should be made to determine this point.

If counterweights for machine tools were made of concrete the size, for a given weight, would have to be increased to about three times the volume, as concrete only weighs about 150 pounds per cubic foot while cast iron weighs 450. If this were no serious objection, there would be the following advantages. The suspending chains could be securely imbedded in the weight when it was cast. The cost would be only a small fraction of that for cast iron. If cast iron cost 3 cents per pound, concrete would probably not exceed one-tenth of a cent. These relative costs deserve careful consideration where the bases and counterweights, etc., constitute a considerable proportion of the cost of the complete machine.

For those who doubt the suitability of this material for the proposed uses, it may not be out of place to mention that one of the big railway bascule bridges in Chicago, if I remember correctly, has concrete counterweights cast into place in the structural steel work. Again the 800,000 pounds testing machine at the University of Wisconsin, which is remarkable for the very low cost of construction, has a reinforced-concrete platform or table which is subject to heavy stresses when testing large beams on long spans. This portion of other testing machines is usually a large steel casting, heavily ribbed.

Some Simple Accurate Boring Fixtures

By M. E. Hoag

Better results than are being secured with the simple crank case boring fixtures, shown in Figs. 1 and 2, have not come to my observations, although I have seen many special machines and fixtures designed for the purpose.

After the milling of all flat surfaces and drilling the bolt and dowel-pin holes, the crank-shaft openings are bored on the lathe shown in Fig. 1. The boring bar is cast iron with inserted blades *A*, *B*, *C*, and is driven by two pins and bolts attached to the face plate of the lathe. The case is located on the bed plate *D* by dowel pins, and is held securely in place by bolts.

Probably the reader's first thought will be that it is something of a job to lift the bar in and out of the lathe. In reality all the lifting the operator has to do is putting on and taking off the cases, to do which he runs the carraige back, places a wooden block under the middle of the bar and withdraws the tailstock, which leaves ample room to remove the finished case and put on a new one.

After boring in the lathe the cases are put on the drill-press fixture shown in Fig. 2, and the cam-shaft and gear-stud holes are bored and reamed. The heavy cast-iron column *A* carries the case and the bushing plate *F*. The roughing tools *C* and bushings, and the finishing reamer *B* are the only tools required for these operations. *D* and *E* are support

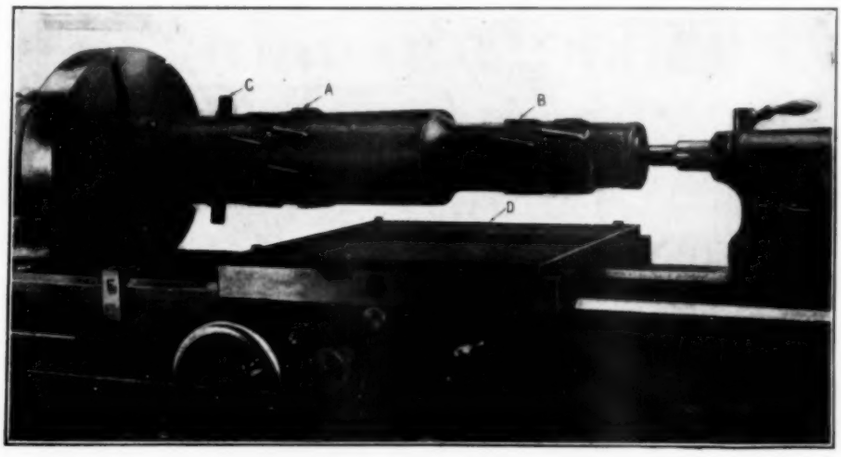


Fig. 1. The Boring Bar

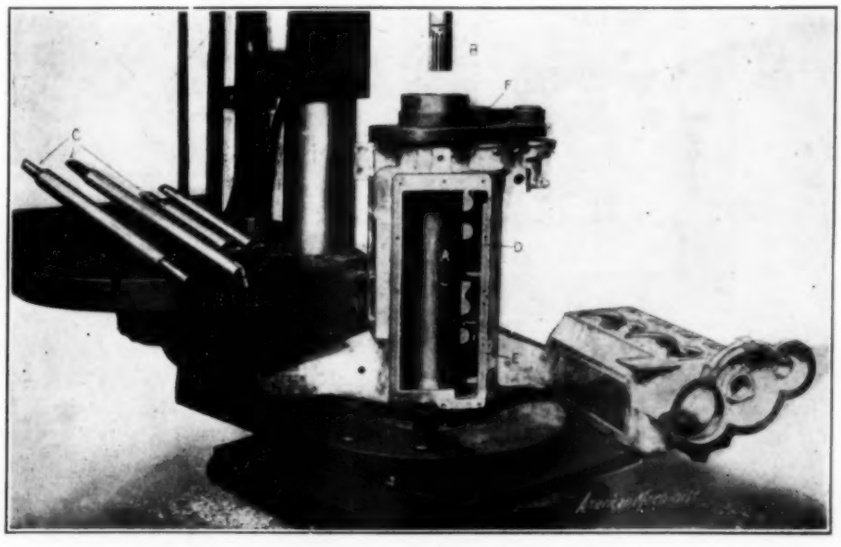


Fig. 2. Boring and Reaming on the Drill Press

Fig. 3. Special Cylinder-boring Machine

bushings for the long boring bars that operate on the lower end of the case.

A Special Cylinder-boring Machine

The machine shown in Fig. 3 is a special Foote-Burt cylinder-boring machine, built for the Davis Manufacturing Company, of Milwaukee, Wis., through whose courtesy I am permitted to present this

article. One feature of this machine is the rising table which advances the work to the spindles, adjustable counterweights at the back of the machine giving the proper balance.

The cylinders are put through two operations on this machine, rough boring and finishing, which leaves 0.012 inch to be removed by grinding.

Sand Blast Tumbling Barrels

By I. W. Chubb

An English development using a low-pressure air blast to convey small shot into a slowly revolving tumbling barrel, containing small castings. Unit costs are given.

The Mathewson sand blast plus rattler appliances supplied by the Tilghman Patent Sand Blast Company, Ltd., Broadheath, near Manchester, England, have been employed for the cleaning of castings, etc., for some little time. They are intended for comparatively small castings, larger pieces than, say, 50 pounds weight, being dealt with in the sand-blast room. Of course, it is not a sand blast that is used, small chilled-iron shot from 1/40 inch to 1/60 inch diameter being employed. The tumbling barrel is supported on rollers and slowly rotated, being driven in any convenient manner.

Fig. 1, which illustrates a barrel plant at the side of a sand-blast room in the works of the Tilghman Company, shows a rattler driven by belt off an overhead motor. The blast itself is taken into one or both ends of the barrel and this is about half filled with castings. With the rotation of the barrel the castings are regularly turned over, presenting new surfaces to the action of the air-propelled shot. As the barrel moves quite slowly, two to four revolutions a minute being made, even light castings will not be broken by the action. The castings are fed into the barrel through a sliding door and perforations allow the dust and shot, etc., to escape through a hopper so as to meet a current of air. This drives the lighter sand away, while the heavier shot falls into a hopper ready for use again.

Fig. 2 illustrates the outfit with sand elevator, separator and air sieve. An exhauster, not shown, maintains a partial vacuum (about 3½ inches water gage) in the tumbling barrel so that any leakage is inward. The sand, etc., is thus drawn to the separator. Shot is used because it does not break up so readily as sand and therefore causes less dust, leading to a clearer atmosphere. Anyone who has seen the results will acknowledge that the castings may be cleaned right down to the metal and a considerable saving in machining cost can readily be claimed.

The plant is supplied in a number of sizes, the smallest dealing with 6 tons in a week of 53 hours and requiring 3 horsepower, while the largest will clean 75 tons a week and takes 40 horsepower.

A Continuous Barrel

A continuous tumbling barrel is also supplied, the castings being fed into the hopper at one end and passing out at the other, after being subjected to the action of four or more sand blasts, according to the length of the barrel.

Costs of Operation

In the ordinary appliance castings up to 50 pounds in size can be cleaned in from 10 to 20 minutes, the time required depending largely on the length of cores. Taking the middle-size appliance, this will deal with 24 tons in a week of 53 hours and requires 10 horsepower for driving. Allowing depreciation on the plant at 10 per cent., interest at 5 per cent., power at rather less than ½ penny ($0.01) per horsepower-hour, wages of attendant at about £70 ($350) a year and replacements at about 10 per cent. of the price of the plant fixed complete, the cost of dealing with 1200 tons a year works out at about 3 shillings ($0.72) a ton or 1.8 pence ($0.036) on the average for each hundredweight.

Again, turning to the plant without the tumbling barrels and using sand blast only on heavier castings. At about the same allowances, except that labor is about £3 ($15) a week, the middle plant supplied, which deals with about 80 tons weekly or say 4000 tons a year, would be run at an average cost of about 2 shillings ($0.48) a ton. With 1 shilling 9 pence ($0.42) for chipping, this gives a total cost for cleaning and fettling of say 3 shillings 9 pence ($0.90) for each ton.

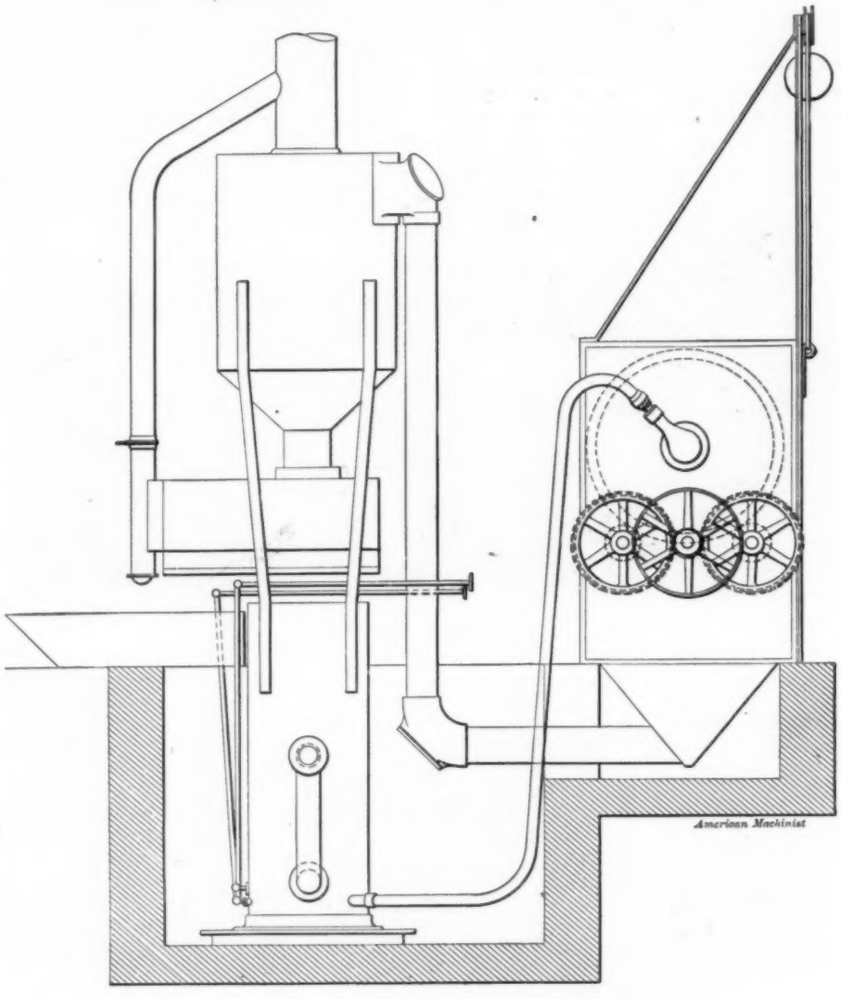


Fig. 2. Diagram of Sand-blast Tumbling Barrel

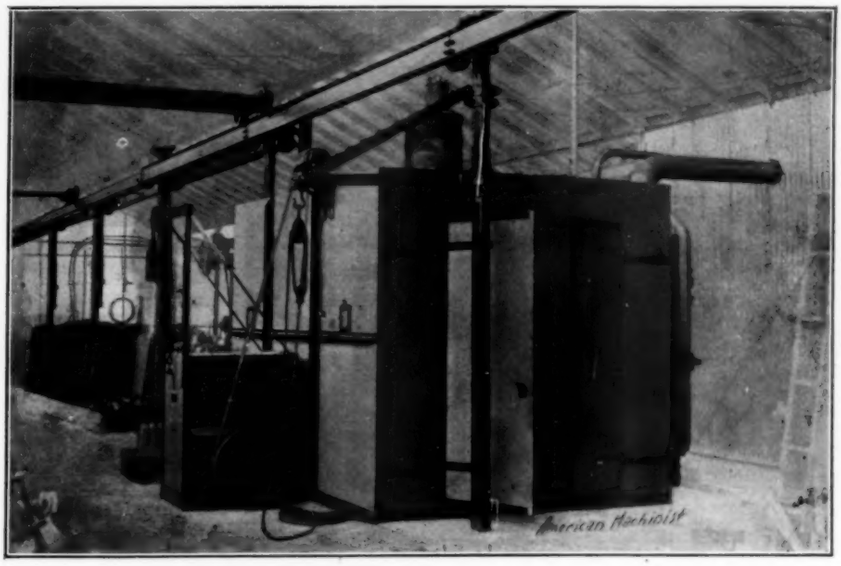


FIG. 1. SAND-BLAST TUMBLING BARRELS

To compare with piecework prices for cleaning castings in Great Britain, these may be taken to average 7 shillings 6 pence ($1.86) a ton, rising from say 4 shillings 6 pence to 10 shillings ($1.18 to $2.40). The process is, therefore, not only quicker and more thorough, but also considerably cheaper.

AIR PRESSURE

A point may be mentioned in regard to the compressed air supply. The makers recommend a large volume at low pressure. The reason will be found in the air velocities corresponding to the different pressures. The work done, of course, depends on the velocity of the shot, and short pipes are used. Now, to make a comparison, through a pipe say three diameters long the velocity at 10 pounds pressure is about 535 feet, a second; at 14.7 pounds, 634 feet; at 29.4 pounds, 656 feet; and at 73.5 pounds only 658 feet. The figures are taken from a well known textbook. It will be plain that after about 15 pounds pressure the velocity rises very slowly. Obviously loss in pressure reduction, from high to low, should be avoided. The firm, therefore, recommend from 5 to 25 or 30 pounds per square inch as a suitable pressure for the air supply.

A Solution of Hobbed Gear Troubles

By Harry H. Asbridge

Analysis of the action of hobs and a modification of the form of the hob by which difficulties have been overcome and success obtained.

This article is suggested by a perusal of Walter G. Groocock's reply on page 411, to George B. Grant's article on page 1148, Volume 33, Part 1, "Why Gear-Hobbing Machines Cut Flats."

I agree with the view Mr. Groocock takes, and while I also am of the opinion that Mr. Grant has not diagnosed the case correctly, at the same time I do not propose to add anything to Mr. Groocock's reply, as I think he has quite covered this portion of the question. Whether there are flats or curves is not, to my mind a vital point.

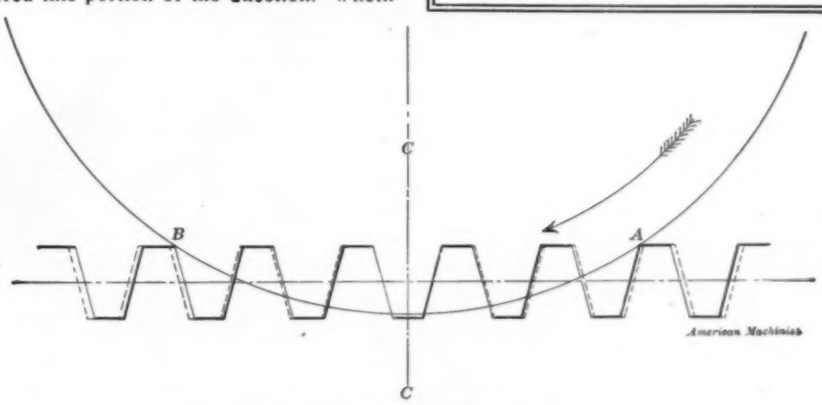


FIG. 1. PROFILE OF THE NEW HOB

SETTING THE SWIVEL SLIDE

Coming back to the query at the head of this article, one cause of unsatisfactory gears as generated by hobs is touched upon by Mr. Grant on page 421, in his article, "Cause of Skew Teeth in Hobbing." Here again I am afraid Mr. Grant is not quite correct. It is possible to set a hob off center (or not to set it at all) and still cut a perfectly straight tooth parallel to the axis of the gear. In this case, as proved by Mr. Grant in his diagram, the only result would be to have a tooth with unequal sides. This is a very common defect and is remedied by setting one tooth of the hob perfectly central. The cause of skew teeth is not in the incorrect centering of the hob, but in the incorrect setting of the swivel slide carrying the hob. A little thought will easily show that when the angle of the hob is incorrect, the hob has a crowding action on one side of the tooth, due to the unequal clearance. It cannot be too strongly impressed on users of hobbing machines, that errors in setting the hob swivel slide are responsible (apart from errors in the hob) for many unsatisfactory gears being turned out, an error of 1/10 of a degree or six minutes being often sufficient to give a skew gear, especially on large pitches. All hobbing machines should be fitted with verniers on the swivel slide reading to 1/10 degree, and if not so fitted should be rejected. Hobs should be periodically examined and checked for the correct setting angle, as every sharpening of the hob affects the angle at which the swivel slide should be set.

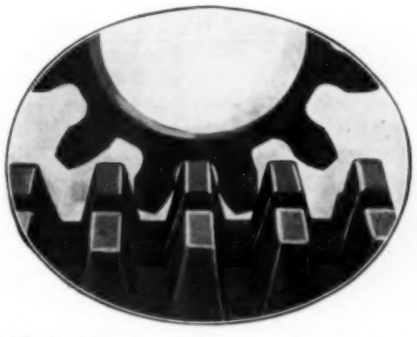


FIG. 2. ORDINARY HOB AND PINION CUT BY IT

Not more than 1/10 degree variation should be allowed from the correct angle. It may be convenient to users to give the formula for this angle:

$$\frac{\textit{Linear pitch of hob}}{(\textit{Dia. of hob} - 2 \times \textit{dedendum})\ 3.1416} = \textit{tan. of angle of swivel slide.}$$

It will be seen, therefore, that it is imperative that the angle of the hob be set correctly, and also that one tooth is central with the gear, just as it is imperative that an ordinary gear cutter must be set perfectly central with the gear being cut, if correct gears are wanted.

Interference of Hobbed Gears

But the most serious objection to hobbed gears is one that I have not as yet seen touched upon by any writer, and this is the interference which takes place at the points of the teeth and which must be removed before quiet-running gears can be guaranteed all the time. This interference varies under different circumstances; given a favorable one, and which would be as follows: The hob as small as possible, the number of gashes in the hob as great as possible, and the number of teeth being cut prime to the number of gashes, and (other settings being correct) a good passable gear will be the result. Given other circumstances the reverse of the above, the result may be had, very bad, or ————. It naturally follows that between the above extremes (and there is no half-way house if good gears are required) hobbing is viewed with considerable dissatisfaction by many users and would-be users.

In all generating systems, whether for spur or bevel gears, provision is made for removing this interference. The generating systems particularly referred to are those in which the gears being cut roll continuously, and the single cutting tool reciprocates across the face of the gear. A little study will show why provision must be made for removing interference at the points of the teeth. It will be noted that while the gear rolls continuously, the cutting or forming of the sides of teeth is intermittent, and while the strokes of the tool are made at a constant speed, the particular portion of the flank of the tooth being operated upon is constantly increasing in speed from the root to the top of the tooth. It will be seen, therefore, that assuming the tool to commence cutting at the root of tooth there is a constantly increasing amount of metal left on, which fails to be removed, owing to the intermittent action of the cutting tool. For this reason provision has to be made for removing this surplus metal, and this is done in various ways which I do not propose to follow just now.

Carrying the above illustration a little farther, assume a gear rolling continuously through a distance of one pitch, the number of strokes which the cutting tool makes in this period is exactly analogous to the number of gashes in a hob, but with this vital difference, that whereas the number of strokes of a reciprocating tool may be anything from 25 or 50 and upward, the number of gashes in a hob is limited to a comparatively small number, generally averaging 9 to 11. I think it will be seen from the above wherein lies the comparative failure of the hobbing system to satisfy users of gears. Various methods have been adopted from time to time to overcome this defect, generally by varying the shape of the hob tooth, but for the reasons given above, anything in this direction is bound to be a failure, or at best only a partial success.

Experiments with Hobbed Gears

At the works of the Churchill Machine Tool Company, Ltd., Manchester, England, with whom I am connected, we are in the unique position of being manufacturers of hobs and also fairly large users of them. It follows that all the defects mentioned in this article and by various writers on the subject have been noted, and a considerable amount of time and money has been spent during the last four or five years in experimenting with various shapes of hob teeth. About two years ago while experimenting with a bevel-gear generating machine with regard to removing the interference previously mentioned, by so governing the action of the reciprocating tool, that more metal is removed from the points of the teeth, it occurred to me to try and adapt the same principle to a hob for spur gears. After several attempts, a method was devised by which the principle mentioned above for removing the interference in bevel-gear teeth could be applied to a hob for generating the teeth of spur gears. The result has been most gratifying. Whereas up to two years ago the results from hobbing were at a discount and absolutely unreliable, bad gears are now the exception, and always the result of careless sizing of the gear blanks or of errors in setting, as mentioned earlier.

A Modified Hob

The method adopted in what is called the New Pattern hob (N.P.) will be clearly understood from the accompanying diagram, Fig. 1, in which the dotted lines show the outline of the cutting face of an ordinary hob, or a straight-sided rack of the correct pitch and the full lines show the cutting face of the N. P. hob. It will be seen that the hob has a pitch which is shorter than the standard hob or of the gear which it is intended to cut. The space is, of course, the correct width, but the tooth is thin.

Referring to the diagram again it will be seen that, assuming the circle to be a gear being cut and rotating in the direction of the arrow, the N.P. hob as indicated at *A* commences to cut earlier than the ordinary hob and gradually slows down in relation to the gear until the center line *C C* is reached. At this point the action is reversed to the opposite sides of the teeth, the gradual slowing down of the hob continuing until a maximum is reached at *B*. The whole method summed up is to start cutting early and finish up late. Apart from the advantage of obtaining better and quieter gears, further advantages are a greater steadiness of the gear while being cut and, of greater importance still, any distortion of the hob in hardening does not affect the work produced to any vital or appreciable extent.

Results

Figs. 2, 3, 4 and 5, are from photographs of 12 tooth pinions as cut by ordinary and N. P. hobs, and, while not so

Fig. 3. Ordinary Hob and Pinion Cut by New Pattern Hob

Fig. 4. New Pattern Hob and Pinion Cut by It

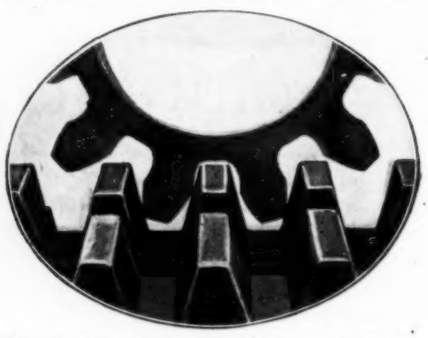


Fig. 5. New Pattern Hob and Pinion Cut by Ordinary Hob

clear as could be wished, they are sufficiently so to show the advantages of the N P. hob.

Fig. 2 shows a 12-tooth pinion in mesh with an ordinary hob, by which it was generated. Note the weakening of the tooth due to undercutting.

Fig. 3 shows a 12-tooth pinion (which was generated by an N. P. hob) in mesh with the same hob as Fig. 2. Note the much stronger form of the tooth, also the clearance between the points of the teeth and the sides of the hob teeth, showing where the interference has been removed.

Fig. 4 shows the same pinion as Fig. 3 in mesh with the N. P. hob by which it was generated.

Fig. 5 shows the same pinion as Fig. 2 (which was cut by an ordinary hob) in mesh with an N. P. hob, showing fouling of points of teeth when interference has not been removed.

While this solution of gear-hobbing difficulties is not put forward as a remedy for all the faults this system is heir to, it has certainly proved its salvation in our own case, and also in those of many of our friends who have been met with difficulties in generating gears with standard hobs, more especially when high speeds were required. It is therefore submitted with the hope that it may prove of use to others encountering similar difficulties.

Two Pneumatic Devices for the Shop

By C. J. Morrison

The sketches show two labor-saving devices for use in railroad shops.

The hoists for air tanks have proved to be tremendous labor savers. One man simply gets the tank on the hoist, wheels it to position under the locomotive and turns on the air. The hoist will hold the tank in position until the fastenings are secured, when it can be easily removed.

The holder on is a device for riveting and is especially adapted for work inside the fire box. One end is placed against the rivet and the other end against the other side of the fire box. The air pressure then holds it in position while the rivet is driven from the outside. The device not only acts quicker, but produces more satisfactory work than any device for holding on by hand.

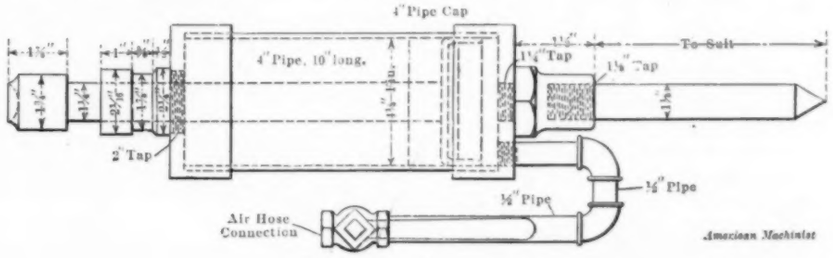


Fig. 1. Air Holder On

The total quantity of Portland, natural, and puzzolan cement produced in the United States during 1909, as ascertained by the United States Geological Survey, was 64,196,386 barrels, valued at $51,232,979. As compared with 1908, when the production was 52,910,925 barrels, valued at $44,477,656, the year 1909 showed an increase of 11,285,461 barrels, or 21.3 per cent., in quantity, and an increase of $6,755,323, or 15.1 per cent. in value.

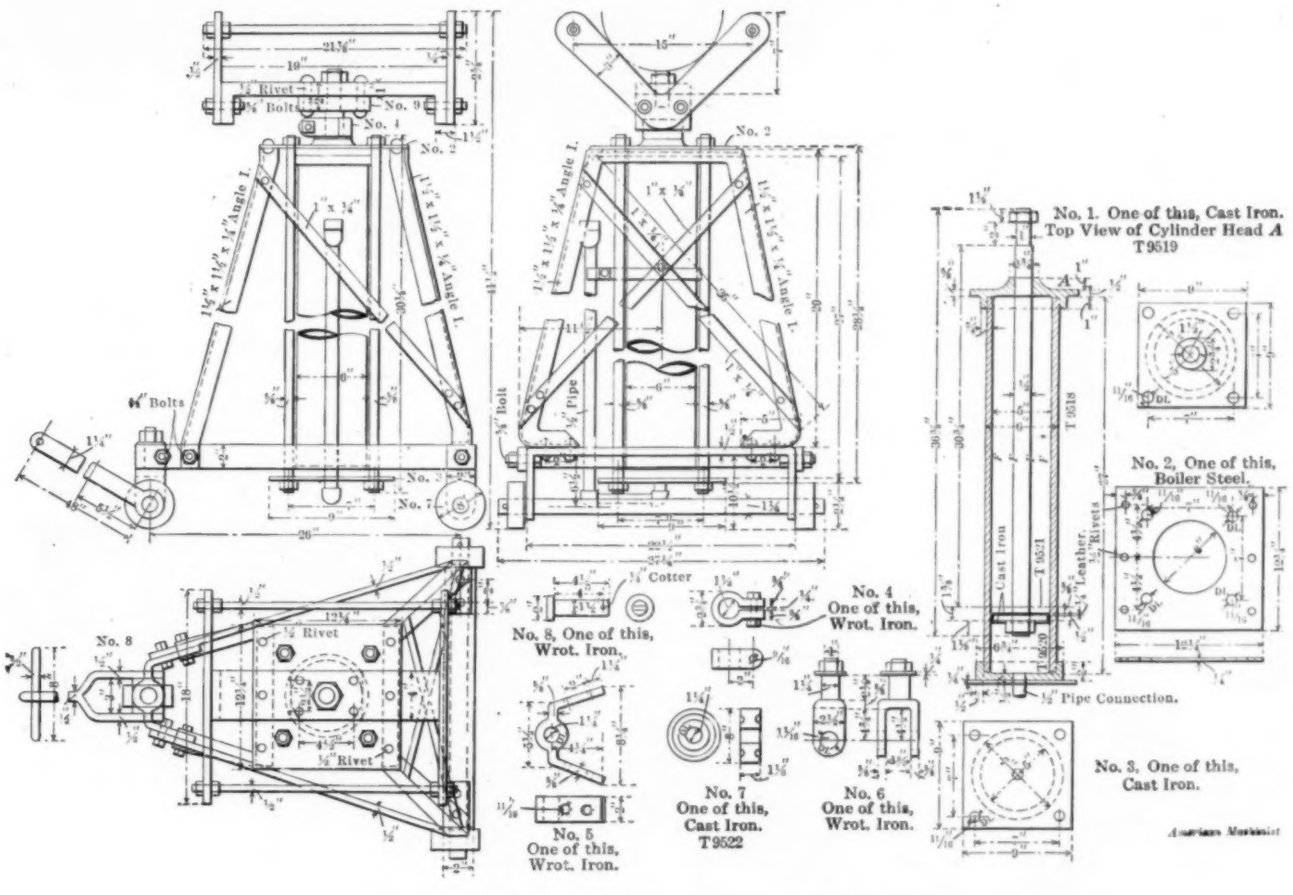

No. 1. One of this, Cast Iron. Top View of Cylinder Head A T9519
No. 2, One of this, Boiler Steel.
No. 3, One of this, Cast Iron.
No. 4 One of this, Wrot. Iron.
No. 5 One of this, Wrot. Iron.
No. 6 One of this, Wrot. Iron.
No. 7 One of this, Cast Iron. T9522
No. 8, One of this, Wrot. Iron.
Pipe Connection.
Cast Iron
Leather
Rivets
Bolts
Rivet
Cotter
Pipe
Bolt
Angle I.
American Machinist

Fig. 2. Air Hoist for Placing Air Tanks on Locomotives

Designing Dies Economically

By G. M. Wolf

The direction of the fiber or grain of the metal, with relation to the blank, and the influence it will have on subsequent operations and duties of the finished product, should be considered before the blanks are cut.

The designing of dies for economical production, consists, not merely in arranging to get a maximum number of blanks from a given quantity of stock, but in considering also whether the blanks when produced will be of such a nature as to lend themselves readily to subsequent operations. Great quantities of blanks are produced which do not undergo any operation which changes their shape from the blank. Many blanks are, however, produced, the blanking of which is only a small step in the sequence of operations through which they may have to pass to reach the form in which they are marketable.

Proper consideration of subsequent operations, the material to be used, and the final use of the article itself are often more important points than the saving of a few pounds of stock, although, of course, this must also be considered. In a previous article on this topic an illustration was given of various layouts of a T-shaped blank, but nothing was said as to what the blank was to be used for. Supposing, however, it was required to form this T-blank as shown here in Fig. 1, that is, the tail of T is formed to a circle, and the top piece is also formed to a circle, the two circles will be at right angles to each other. To do this successfully a good quality of stock must be used and the grain or fiber of the metal must also be considered. The more grain or fiber in the stock, the more care is needed to dispose it to the best advantage. Good results with the fiber running in directions parallel to either member of the T could hardly be expected, so that in this case the arrangement which produced most blanks would also be the best as regards the circling operations, because the fiber is so disposed as to favor the circling of the one part of the blank as much as the other. Should it be desired to form the same blank as shown here in Fig. 2, this is a test, in some respects, more severe than the one shown in Fig. 1. The same arrangement of blanks with the stock would be just as suitable, and would produce good results. If an article is to be produced which may have to withstand a tensile strain, care must be taken so that if the fiber of the stock cannot be disposed to the very best tensile advantage, it shall at least not be disposed in the very worst, viz., in a transverse manner. Thus by cutting the blanks at an angle with the stock, a compromise between the two parts of the blank is effected and economy of stock is secured at the same time.

There are cases when there is only one way to cut the blank, as for example, Fig. 3 shows a portion of a blank which has a part slit and depressed. The material of which this blank was made, half-hard brass, precluded all idea of cutting blanks in any way except with the fiber running lengthways, although the shape of the blank was such that had blanks only been required many more might have been obtained from the same amount of material. Fig. 4 shows a spring made of german silver of a somewhat hard character. If this were cut with the fiber lengthways of the blank it was excellent in action as a spring but the two ears which are bent down broke off and thus rendered it useless. If it were cut with the fiber across the blank, breakage occurred across the blank near the ears, or at the other end where the parallel parts join the end, that is close to the head of the fixing screw, although in this case the ears were readily bent to the desired form. By cutting the blanks with the fiber running diagonal to the blank, trouble was averted.

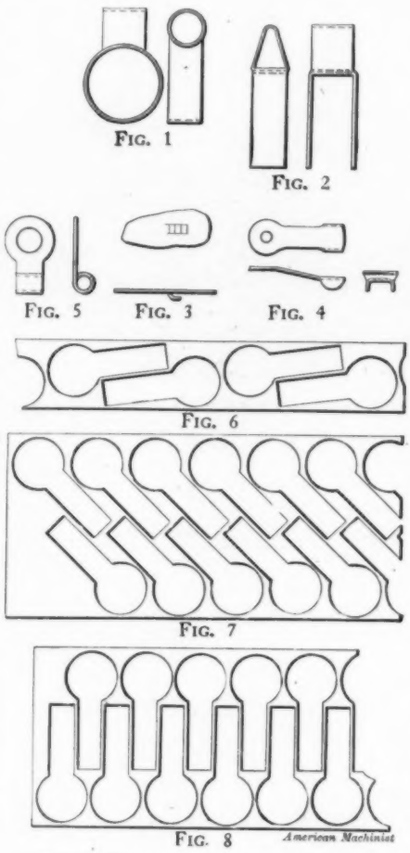


FIG. 1 FIG. 2 FIG. 5 FIG. 3 FIG. 4 FIG. 6 FIG. 7 FIG. 8

DESIGNING DIES ECONOMICALLY

Take the case of an article similar to the one shown in Fig. 5. Here is a blank which has one of its ends curled. It is usual in an operation of this character to get a little lead for the curled part by so shaping the cutting punch that the blank "follows the punch" and a slight curl is obtained at the end of the blank at the one operation. The whole of the curl may then be obtained in another operation, thus saving an operation. Often if curling be tried without a lead, the blanks are stubborn and kinks are formed, especially when the fiber is across the blank, or at only a slight angle from it. Three layouts for this blank are shown, Fig. 6 is the one where the fiber most nearly approximates the ideal condition for curling; in this instance 132 square inches of stock are required to cut 100 blanks. In Fig. 8 the stock is laid out to the best advantage should blanks only be required, but as will be seen the stock has its fiber in the worst condition for curling, viz., in a transverse direction. In this layout 106.6 square inches of stock are required to cut a hundred blanks. By adopting the layout of Fig. 7 good results were obtained as to curling at a slight increase in the amount of stock, as this way took 116 square inches per hundred blanks, an increase of 10 square inches per hundred blanks over Fig. 8, the most economical layout; an extra cost which paid for itself, in that all the blanks would curl and no wasters were made through kinks and fractures.

Care should be taken to see, in cases where the usefulness of the blank depends upon which way the fiber is disposed, that the operator cuts them that way and no other. Inspection of Fig. 7 will show that at the starting end of the stock there is sufficient material to cut another blank. However, if this be cut the blank will not be so suitable for curling and for an operation as shown in Figs. 3 and 4 would be altogether useless.

The production in the United States of iron and steel plate for the manufacture of cut nails and cut spikes in 1909, as ascertained by the American Iron and Steel Association, amounted to 63,746 tons, against 45,747 tons in 1908, an increase of 17,999 tons, or over 39.3 per cent. Of the total production in 1909 about 47,822 tons were steel and about 15,924 tons were iron, against about 30,265 tons of steel and about 15,482 tons of iron in 1908, an increase in steel nail and spike plate of 17,557 tons and in iron nail and spike plate of 442 tons.

Letters from Practical Men

Concerning the details of making things in machine shops, from the first sketch to the shipping room.

A letter good enough to print is good enough to pay for. The value is in the idea—not the length of the letter.

A Rack Cutting Attachment for the Gear Cutter

In the manufacture of envelop machinery a number of short racks are required. There are, however, not enough of these to warrant the purchase of a rack cutter. Mr. Froelich, superintendent for F. L. Schmidt, Twenty-first street and Eleventh avenue, New York, designed the attachment shown for a No. 3 Brown & Sharpe spur gear cutter.

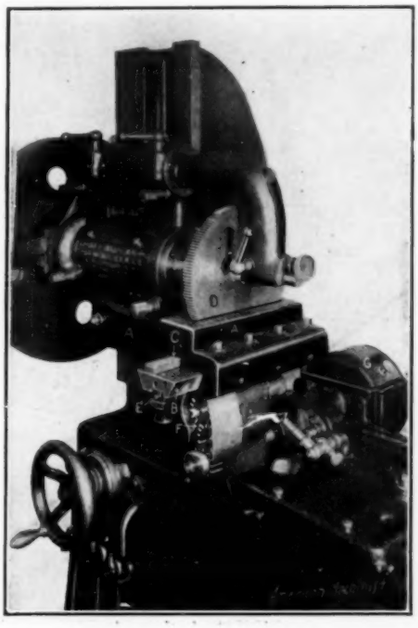


FIG. 1. GENERAL VIEW OF THE FIXTURE

Fig. 1 shows a general view of the device. The bracket *A* is bolted to the housing of the machine. It carries the slide *B* which has a 12-pitch rack *C*. This rack meshes with the gear *D*. The underneath face of the slide *B* has a longitudinal slot *E* into which the blanks for the racks are secured by means of screws. This method of fastening is perfectly satisfactory in this case but a vise could be readily attached to the lower surface of the slide *B*.

The cutter is driven by the train of gears *F*. These were made necessary in order to have the rack blank high enough to pass the gear cover *G*. Although used for racks less than a foot long any length of rack could be cut by shifting it in the groove *E*. Fig. 2 shows a front view of the fixture with a partly finished rack *I* and the cutter *H*.

Fig. 3 shows a rear side view of the fixture with a partly cut rack in place.

New York. E. A. DIXIE.

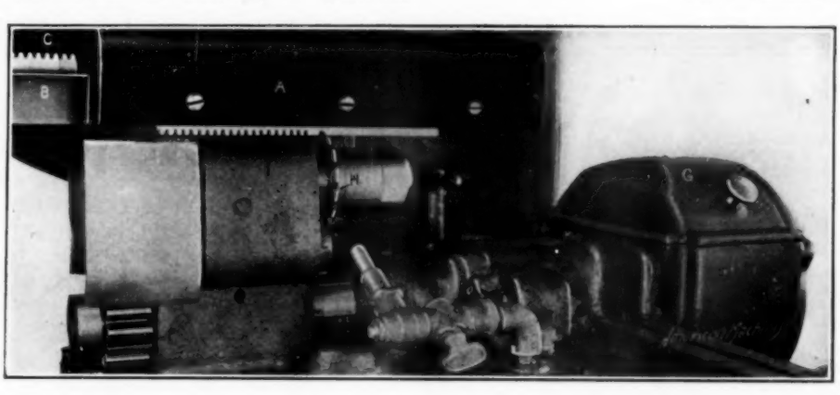


FIG. 2. FRONT VIEW OF THE FIXTURE

Securing the Caps to the Slide of a Punch Press

The slide and slide cap on a Styles & Parker punch press as usually built and supplied by the makers, are fastened together by means of a hex. head screw, tapped into the slide from the front. It frequently happens that the threads of the screw are stripped by accident or long wear, and it is necessary to retap the slide, redrill the cap, and use a larger screw. There is a limit beyond which this practice cannot be carried and some other means must be found to repair the damage.

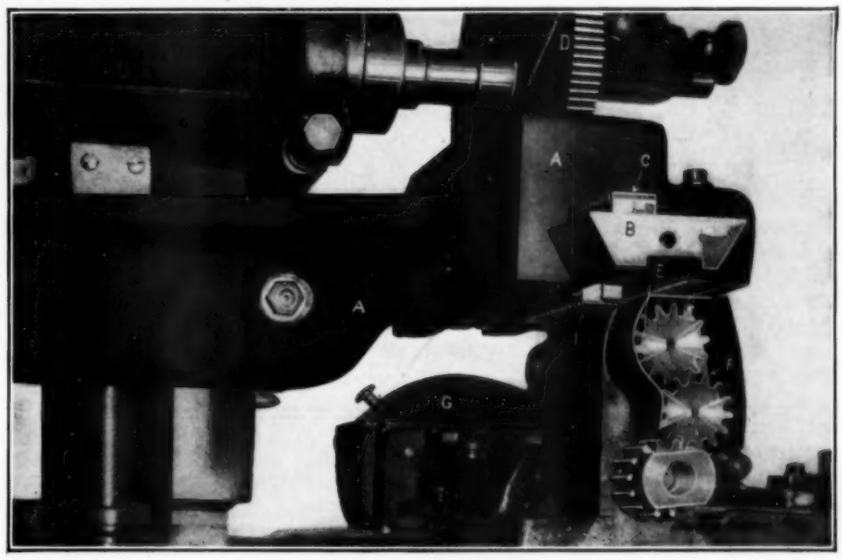


FIG. 3. REAR VIEW OF THE FIXTURE

A means adopted in a shop where I was formerly employed, was to counterbore and drill the slide and drill the cap to take an ordinary machine bolt, the thread of which projects through the cap, and a nut and check nut used to fasten the whole together. Now when the threads are stripped it is only necessary to provide a new bolt, and the press is ready for business again immediately.

Another method is to tap a stud into the slide in the hole originally intended for the screw, and allow it to project from the cap to take a nut and check nut as before, and no doubt this method would be preferred by many.

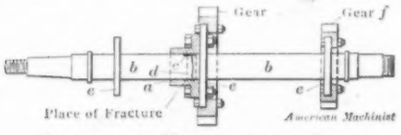
Another advantage either of the latter mentioned methods possesses it that when it is necessary to remove the cap, it is only necessary to remove four nuts and the cap itself, instead of two screws and the cap. The screws are likely to be mislaid or lost if not screwed back into the slide when the cap is removed, and if a couple of nuts should be mislaid others can generally be secured without trouble.

Philadelphia, Penn. J. H. HARRIS.

Repair of the Driving Axle of a Motor Truck

The driving axle of a motor truck used for carrying coal, etc., at a mine, was broken off at the place marked in the sketch. No reserve axle was on hand, and an interruption of service would have been unavoidable. I therefore decided to repair the broken axle in the following manner:

From an axle end, which happened to be available, I had turned on a lathe a coupling *a*, rough outside, inside bored for a shrink fit. At the same time a keyway was cut running diametrically through the fractured ends at *d*. The coupling *a* was pulled hot on the axle end at b_1 and fastened by means of a pin *c*. Then the flange of the axle and the coupling were accurately drilled for a



REPAIR TO MOTOR-TRUCK AXLE

number of bolt holes and some bolts which happened to be available were inserted. The axle was mounted on the lathe between centers, and the nuts dressed off together, so that there should be no knocking in the axle. Finally the nuts were locked. The toothed rim *f* was replaced on the flange *e* of the driving axle, and the latter mounted once more on the truck.

The entire repair of the axle took seven hours' work; the truck could, therefore, resume service within a day.

At the same time a telegraphic order was sent to the factory for a new axle, which took six days to arrive. After running without fault for three months, the repaired axle was replaced by the new one, upon the occasion of other repairs which required entire dismantlement of the truck.

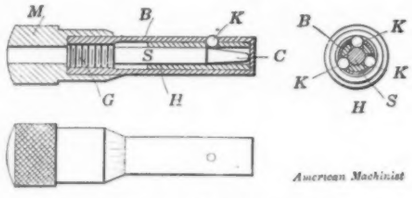
Bensberg, Germany. W. LIMBERG

A Plug Micrometer

The accompanying illustration shows a plug micrometer having a hardened bushing *H*, with three holes to receive the balls *K*. The bushing *H* is inserted in the barrel *B*. The holes in the barrel are bored rather small, so that at most only one-third of the diameter of the ball can project. The barrel *B* is graduated longitudinally and threaded inside to receive the pin *S*. This pin is provided at one end with the cone *C* and is fixed in the sleeve *M*, which is graduated. By turning the sleeve *M* the pin will screw forward or backward, its cone *C* forcing the balls *K* outward or letting them come inward.

In measuring a hole the pin *S* is screwed out so far that the balls do not project through the barrel *B*, therefore, resting on the smallest diameter of the cone *C*. Then the instrument is inserted in the hole that is to be measured, and the pin *S* screwed is in so far that the balls touch the sides of the holes. The diameter is then quickly read on the scale.

The accuracy of the instrument is naturally dependent upon: First, the thread;



A PLUG MICROMETER

second, the cone; third, the balls. The smallest instrument is made for a hole from six to seven millimeters (0.25 inch) in diameter. It is, therefore, necessary to have a number of instruments in order to measure holes of greatly varying diameters.

Munich, Germany. HERM HIPPLE.

Electric Driven Planer

One of the machines exhibited at the Brussels exhibition by the Billeter & Klunz firm, of Aschersleben, was a single-pillar or open-side electric-driven planer to take in 42 inches wide and 35 inches high, the width of table 33.5 inches. This machine was driven by a reversible electric motor of about 8 horsepower, which could be run up to 12 horsepower for a spurt.

The peculiarity of this motor and of its arrangement consists in the fact that it is fitted with the Leonard step-down attachment, made by the Lahmeyer establishment. With this arrangement, the transformer does not get its current directly from the main circuit, but from a special dynamo, which is driven by a motor directly run from the circuit. It is also possible to drive the dynamo from a shaft and a small steam engine or gas motor. Between the motor and the dynamo there is a coupling, supplied with a flywheel attachment. As the drive of the dynamo takes place with constant velocity, the driving motor may be worked with either continuous or alternating current. The planer motor and the dynamo form a special current circuit, independent of the main line. By reason of this separation, and of the avoidance of shocks, thus obtained, this arrangement may be used in connection with a very sensitive lighting circuit.

The starting and reversing of the planer is effected by exciting the dynamo. This causes tension in the motor, and this tension and the speed of the motor will be in proportion to the strength and direction of the excitation.

For this reason, to reverse and to vary the speed it is necessary only to reverse or to vary the slight exciting current. This is done by a small device attached to the bed of the planer and operated by a dog or by a so-called "boot-jack" movement. As this reverser receives only a slight current, the wear of the contacts is but slight. The regulation of the working and the return speed can be arranged for independently of each other, for instance, there may be a variable cutting speed and a constant return with maximum velocity. The speed is variable from nothing up the maximum, in small increments. The table movement is constant, so that one can practically plane up to a definite cross line. This device also permits of very short cutting strokes. If there is more than one planer to be driven, it is not necessary to have a special transformer for each machine, but there may be a common driving motor with intermediate coupling for each machine. In shops where for exciting the primary machine and the planer motor there is no continuous current of about two kilowatts, this exciting current must be generated by a small dynamo in connection with the transformer.

The planer itself has a bed reaching to the floor; the pull reckoned at the table is about 2530 kilograms (5566 pounds); the maximum cutting speed 140 millimeters per second, or about 27.7 feet per minute; the return speed, 450 millimeters per second, or about 866 feet per minute. The pillar is circular and hollow; the hollow horizontal arm is of triangular plan, and substantially braced.

The pillar is cast vertically; and is twice as thick at the foot as at the head. There is an arrangement by which the horizontal arm may be adjusted at right angles to the lengthwise axis of the table, in case through carelessness of the workman it should not have been drawn up tightly enough. The drive is back of the column, so as not to be in the way. The machine can be fitted with a saddle on the vertical column, which is, of course, to be recommended. The column and the bed are so arranged that this saddle can plane the entire side of the work piece.

ROBERT GRIMSHAW.

Dresden, Germany.

Discussion of Previous Question

Industrial Schools and Apprenticeship

Letters from our readers showing how many men of many minds look upon various subjects opened up in previous numbers.

Professor Kimball's complete article on the above subject, beginning on page 958, covers the field in a very exhaustive manner and is a valuable contribution to a live subject. Having had a considerable acquaintance with technical men, both before and after graduation, and some experience with trade-school boys, I have arrived at different conclusions with regard to some points. I hope that no one will suspect me of disagreeing on all points because I criticize a few.

The diagram showing the "Relative Values of Technical Knowledge in Various Fields" on page 958 seems to me to fail to represent the condition of either shop-trained, trade-school trained or technically trained men. It seems to me that it is more nearly correct to place the acquirements of a 14 year old boy at 0 in all three counts. His manual skill, even with manual training in the lower schools is certainly as likely as not to be below zero, his scientific knowledge I have been unable to find and his manufacturing knowledge is something that he is unable to locate. At 14 we should have a healthy normal animal, with the ability to read, write and cipher, when he is held down to it. He does not understand what he reads, he cannot express his thought in writing and he cannot add 2 and 2 and be sure that he is right. I am inclined to think that this is as it should be though I believe that the fact of his being a healthy animal at that age is the most important feature.

Relations of Technical Knowledge of Boy Who Picks Up His Trade

I have endeavored to show in my Fig. 1 the way in which the ordinary shop-trained boy advances and the relative amount of manual skill, manufacturing knowledge and scientific knowledge that he acquires at various ages.

While these curves approximate the curve of beauty in their general direction, I prefer to follow Professor Sweet's lead and advocate the straight-line path of training which appears in other diagrams. By a shop-trained boy I mean one who practically picks up his trade whether indentured or not. The newer apprenticeships where boys are really taught to do things in the shops I class under the head of trade schools for the purposes of this article.

When such a boy first enters a shop his progress is necessarily slow. He is set to doing things that he cannot spoil by any chance. He is acquiring an acquaintance with the shop and shop ways and he is doing it much as our immigrants learn to swear as their first steps of learning the language. That is, he learns the wrong thing first. Having learned the tricks by which the journeymen fool the boss he begins to get a chance which he averages to improve slightly and he rounds into a considerable degree of manual dexterity advancing at the highest rate about the eighteenth and nineteenth years. Then he goes from the old shop and knocks about for the remaining years up to 23, when he settles to something definite with a line of future progress probably averaging to be a straight line up to his, say, fiftieth year.

At about 18 years of age he begins to have some glimmerings of scientific knowledge, though he likely does not call it by that name. He can figure the outside diameter of a gear, he can intelligently guess the weight of a plain casting, he knows something about the leverage of a crowbar and the best way to rig a tackle. He knows that a roller travels only half as fast as the machine rolled on it, he knows how to figure the horsepower transmitted by a belt and he knows a large number of other scientific near facts and some not even near. Two years later he may begin to suspect that there is a connection between the time spent in building a machine and its cost. He begins to realize the advantages of jigs and fixtures and of an abundance of small tools. If he goes into business for himself he finds that what he has acquired in the way of manufacturing knowledge is only a drop in the bucket. The horizontal intercepts as drawn represent as nearly as I can approximate, not the time spent in acquiring knowledge and skill, but their money value to him.

Relations of Technical Knowledge of Technical Graduate

Now let us turn to the technical graduate, Fig. 2. From 14 to 19 years of age (average age of entrance to the technical school) his acquirements are purely scientific. I fail to see anything in manual training to justify rating it as a portion of manual dexterity even as practised in high schools. It is true that there are a few notable exceptions to this last statement, but they are so few in numbers that they affect the general average only slightly. At entrance to the technical school progress in manual skill begins and advances uniformly through the course, but only to a point not over 20 per cent. of that acquired by the shop boy. No doubt exceptions will be taken to this statement by those who have seen the fine exhibits made by technical schools. It should be constantly borne in mind that speed is an absolutely essential part of skill and that the technical graduate is very deficient in that respect, as his employer will freely testify.

The student's scientific knowledge increases, but at no higher rate than before for the first two years, owing to the universal tendency to make the later years of the course attractive by making the first part of the course worthless without the addition of the last two—a reprehensible tendency but one so deeply rooted as to be ineradicable.

Manufacturing knowledge begins later than with the shop-trained boy, but does not advance any more rapidly. To be sure there are one or two notable exceptions, particularly at the Worcester Polytechnic Institute, but they hardly affect the general average. That there could profitably be a great deal more done in this line is admitted, but the difficulties, without the coöperation of an active commercial shop, are probably prohibitive.

Relations of Technical Knowledge of Trade-school Boy

Now to turn to the trade-school boy. At present there have not been enough boys graduated from trade schools so that any positive statements can be made. The diagram, Fig. 3, is largely conjectural, or possibly, ideal. Both manual skill and scientific knowledge begin to grow from the fourteenth year. As before, the ratio shown is not the number of hours of study or work, but relative value to the student, as shown by his earning capacity. At 19 years, average age of graduation, the boy should have even more manual skill than the shop boy, because he has been instructed in the trade, while the other has had to pick it up. He has less scientific knowledge than the boy who goes to the technical school through high school, but he has some manufacturing knowledge, as much at least as the average technical graduate. If he does not the trade school has failed. After graduation the trade-school boy will advance in manual skill nearly as rapidly

as while in school, because he will have formed right habits of thought and work which his advance in maturity will make more valuable to him and incidentally his employer.

His advance in scientific knowledge during this time will probably be a little greater than that of the shop-trained boy for the same reason, and his advance in manufacturing knowledge will be still faster because his employer, finding him as well fitted in that direction as the technical-school graduate, will put him in position to develop it.

As for keeping courses open at the top, I believe in it fully—but I believe that the most valuable opening at the top for the trade school is that of the largest university of all—the university of hard knocks. I would make the transition from school to university an almost imperceptible one, and I believe that the technical schools could do the same to good advantage.

We should recognize that there are usually a number of best ways for men of different temperaments to reach a given hight. Manual skill does not prove executive ability nor does executive ability prove manual dexterity, and ability to design proves neither. There is a large group of successful men in this country who could never have graduated from a technical school. They admit it and the records of the schools show it. There is a large number of men who have succeeded without manual dexterity. The more roads are opened leading to success, the more can attain it. The trade school opens a slower, surer road to success than the technical school, and a quicker, surer road than the shop. The bright, aggressive boy cannot wait for the trade school. The slow, thorough boy cannot stand the technical pace, but he is just as likely to attain a high position in the end whether he goes up through the shop or the trade school, only he will be given greater encouragement and better incentive in the trade school.

Springfield, Mass. ENTROPY.

Swiss and Italian Trade Schools

Having read with interest the articles which have appeared in different issues of the AMERICAN MACHINIST regarding trade schools, both in the United States and in Europe, I wish to add a few comments on trade teaching in Switzerland and Italy, based on what I have seen in the course of my travels.

In Switzerland, teaching in general is left to the governments of the different little states called cantons. Trade schools are generally organized on the same lines as in Germany. The canton of Zürich, which does most of all in the way of trade education, has a law requiring a written agreement between the parents of an apprentice and the firm, and under the control of the government. The boy has to follow certain courses planned by the board of trade education and suitable for the trade he is learning. Lessons are given both during day time and at night in the so called Gewerbeschulen and it is the duty of the firm to give the boy the necessary time for his studies. The school is never connected with the workshop. At the end of his term of three to four years for the mechanical profession, the boy is requested to pass an examination, both practical and theoretical, before government inspectors. If he fails, the cause thereof is traced back, and in case of the firm being at fault, proper compensation has to be given. As already said, these conditions exist only in the canton of Zürich, and came in force about three years ago.

Two large technical schools (called Technikum) in Winterthur and in Bienne, besides purely theoretical courses in civil, mechanical and electrical engineering have also a real trade school, as that term is understood in the United States, called Mechaniker Schule (machinist's school). The boys receive elementary knowledge of mathematics, drawing, shop calculations and materials, and are trained practically at the different machines and at the bench. The term is of three years, and at the end of it, the boys generally follow the special trade known in Germany as Feinmechaniker (toolmaker or instrumentmaker). The work done in these schools is not put on the market (so far as I know) and consists mostly of tools, small machine tools and repairs to machines in the shop.

In the French speaking part of Switzerland, in Chands de Fonds, the center of the watch manufacture, I visited four years ago, the "Ecole de mécanique et d' horlogerie" (mechanics and watchmakers' school). The school is controlled by the city government, and both trades are taught in a practical way. Both divisions have common courses in language, mathematics, mechanics, materials and drafting. Every boy learning watchmaking has to furnish a complete watchmaker's bench lathe, and he is taught step by step how to make the different parts of a watch according to factory practice. In the mechanic's school, they build a fine measuring machine, something like a watchmaker's lathe, about two feet long.

The boys are taught how to follow the sequence of operations for each part; those operations being written in a note book and made plain by sketches. The workshop includes a pattern shop, a small foundry, blacksmith shop, a machine to test strength of materials, and all the equipment of a machine shop. It is to be understood that these two schools are for those boys who can afford to spend three years without wages, furnishing books and tools, paying a certain school fee, and who wish to learn their trade in a refined and thorough way. Hence they are not well acquainted with real factory working conditions. Trade schools of the same system, mostly under government control, are scattered in other little towns of the watchmaking provinces.

In Italy, my observation has been limited to Milan, and fellow workmen from other towns made me to understand that this city does most in the line of trade teaching. The "Scuola d' Incorraggianesto d' Arte e Mestieri (school for the encouragement of applied arts and trades) is controlled partly by the city government, by private institutions and by some large firms. All courses are night or Sunday morning courses from October till May, and include no practical work except drafing, so far as the mechanical profession is concerned. Generally the boys find work in a shop, and do the best they can, according to conditions, to pick up some knowledge of factory work. There is no regular apprenticeship, and very few of the boys are presevering enough to attend night schools. As soon as their wages are high enough to make them step up to the degree of a journeyman, most of them abandon all kinds of study.

As I came to the United States only ten months ago, my opinion of the American way of teaching trades cannot be very important, but it seems to me that city and State governments ought to take a more active part in the matter, in order to arouse more general interest and thus bring about more effective results at a smaller cost, and bring the field of practical engineering into higher esteem among the boys of today, just as is being done in certain Western States along the line of practical agriculture.

Rochester, N. Y. S. MORIER.

More about Flats on Hobbed Gear Teeth

Anything from the pen of Professor Sweet is bound to attract attention and it is quite certain that many gearwise people have given his contribution on page 741, on the "Flats on Hobbed-Gear Teeth" discussion, the careful consideration it deserves.

Professor Sweet hints that the flats and ridges on hobbed gear teeth are or may be quite desirable, and in support of that opinion he says that for many years he has believed that a rough-bored cylinder is better than a smooth one. The inference here is that the rough-bored cylinder and piston surfaces are comparable with the rough, flatted surfaces of the hob-cut gear teeth. They certainly look alike, the flats on some of the gear work turned out in the desperate effort to keep up with the claims for enormous

output, being visible at a considerable distance.

I will not attempt to discuss the rough-bored cylinder question or claim to understand the matter, but I must say that the two cases are not at all comparable. The contact between the cylinder and piston is between two broad surfaces that exactly fit and slide on each other, but the contact between two gear teeth is along a single line.

The piston rings and cylinder should bear on each other with a pressure that is just sufficient to prevent the passage of steam, anything greater being a defect that creates friction and wastes power, while the two gear teeth bear on each other with all the force being transmitted. The two cases are in this particular very far apart and cannot be made to support each other. The piston is guided primarily by the bearings or guides of the piston rod, and no matter how rough the cylinder and piston may be finished, the hollows and ridges cannot cause any such bump, bump, bump motion as in the totally different case of the rough-finished hobbed-tooth surfaces grinding on each other with the full force of all the power being transmitted by the gears.

When coarsely hobbed and very much flatted gear teeth bear on each other, the action is comparable to that of a loaded wagon on a corduroy road.

My thirty and more years of experience have taught me that gear consumers like their gear teeth as smooth as glass and are critical with regard to scratches and similar defects, but now some seem to be advocating the rough tooth surface on the ground that the ridges will soon wear down and make no trouble. If we should proceed on that basis we should expect to be in trouble about all the time.

Switching off of the subject of hobbed gear teeth Professor Sweet cites a case in actual practice in which some gears were cut with cutters so rounding that the tops of the teeth were out of the way altogether, the contact being supposed to be at the pitch line or very near it. That reminds me of a practical gear man, who died 20 years ago, who used only the 12-tooth cutter of each Brown & Sharpe set. He cut all sizes, 12 teeth, 20 teeth, or a rack, with the same 12-tooth cutter, and his gears went with a certain class of mechanics. When one gear went round the other followed it after a fashion.

If we could cut all gears that way, the gear-cutting business, as well as the cutter-making business, would be greatly simplified, but, unfortunately, the gear consumers read the AMERICAN MACHINIST regularly, and as they wax more and more learned and gearwise they wax more and more particular, until we poor gear makers are hard pressed for ways and means to get results good enough to suit them.

Philadelphia, Penn. GEO. B. GRANT.

Blueprinting from Typewritten Copy

Kindly permit me to say something about the duplication of typewritten work in reply to the letter by T. H. Harris on page 888.

Perhaps few men in the country have had as much experience as myself in writing specifications, etc., on thin paper on any ordinary typewriter, using a black ribbon with a black carbon reversed on the back of the sheet. Mr. Harris seems to think that every man can own an Elliott book typewriter. Since the greater number cannot afford anything better than an ordinary typewriter, I wish to say that he exaggerates the troubles had with the work done on an ordinary typewriter. I have had classes of men numbering 25, and all the notes were given to them in that way. Of each sheet 25 copies were made. I have sheets over three years old from which prints were made last week, the total from those sheets in the past three years running up over 100 copies, yet the sheets are seemingly as good as ever and are not smudged very badly. The smudging is not so bad that it obscures in the slightest degree the printing from the sheet.

I have prepared hundreds of sheets for blueprinting and have never had any of the letters cut pieces out of the carbon. I have tried tonight to see if it can be done and have failed to get results. Perhaps Mr. Harris will explain the peculiarities of the process whereby such things can happen. Perhaps he does not know how to do it. Here is the method I have used: The paper should not be soft, but should be a thin, hard, tough paper. The stock I prefer and try to get is a thin Damascus bond, and it is not high priced. Use a black ribbon in the typewriter; a purple ribbon is not so good. Place the paper in the machine in the regular way and write on the paper. On the back of the sheet place a black carbon so that when the type strikes the paper the ink will make a mark on the face and the carbon will make a mark on the back.

An ink carbon will seldom give satisfactory work, for it is too thinly coated with carbon; always use a pencil carbon, for it does carry plenty of carbon. I admit it smudges the fingers a trifle and if the paper is handled roughly it smudges the back of the paper, but this smudging, if the sheets are handled with reasonable care, does not affect the printing. After the sheets have been used a few times a great deal of the excess carbon is rubbed off or sinks into the paper, for I know that my sheets three years old do not smudge any more and still the prints are very clear.

As is the case with the ordinary writing, the type should be kept clean in order to get good impressions on the paper.

Chicago, Ill. ERNEST MCCULLOUGH.

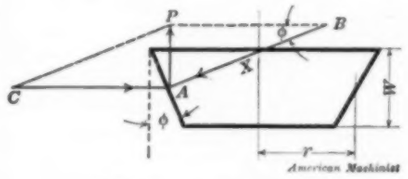
Designing Cone Clutches

A correspondent has called our attention to the fact that the cut and formulas given in the article entitled "Designing Cone Clutches," on page 532, are not clear. In order to put the matter right, the accompanying cut is presented, showing the forces acting upon the clutch surfaces.

For automobile work, the width of clutch should be such that the pressure normal to the friction surfaces should not exceed 45 pounds per square inch. In such designs, however, the width of clutch parallel to the shaft is more usually known than the diagonal width of the engaging surfaces and, as the difference between these two dimensions is slight, the following formula will give a unit pressure near enough to 45 pounds for all practical purposes:

$$W = \frac{X}{2\pi r\, 45}.$$

In this formula, W is the dimension shown, in inches; r is the mean radius of



FORCES ON THE CONE

the cone in inches; and X is the total normal component of the force of the spring in pounds. In the cut this is represented by force AB, where P is the total force of the clutch spring in pounds, and C is the resistance to bursting of the outer cone.

From the triangle of forces,

$$X = \frac{P}{\sin.\ \phi},$$

where ϕ is the angle of the clutch, usually about 12½ degrees.

In order to have all of the data together, the horsepower formula is here repeated, as follows:

$$H.P. = \frac{P f r R}{63{,}000 \sin.\ \phi},$$

in which

$H.P.$ = Horsepower of clutch;
P = Pressure of engaging spring in pounds;
f = Coefficient of friction of surfaces;
r = Mean radius of cone, in inches;
R = Revolutions per minute;
ϕ = Angle of the clutch, as shown in cut.

ED.

The Open Shop for Visitors

Referring to the article by "Entropy," on page 931: The attitude of the manufacturer toward the representative of the Government who seeks admission to his innermost secrets, may possibly be of some interest, since the Government is one of the largest and most persistent buyers in the small-tool and machine-tool lines, and one that cannot possibly be regarded as a competitor in these lines.

About a year ago I was detailed to visit and inspect the plants of a considerable number of the largest and most successful manufacturers of small tools in this country, for purposes of obtaining certain information bearing on the use of such tools by the Government.

Contrary to expectation, practically no difficulty was encountered in securing permission to inspect all processes of manufacture, *except the heat treatment.* This department was visited in all but three plants; however, several conferences with the president of one large company being necessary before admission was gained. Information of the greatest value, that was the result of years of experiment and manufacture, was obtained through the courteous treatment extended, which was always with the express understanding, of course, that none of this information should be allowed to reach a competitor.

This brings us to the remarkable fact that, out of some 20 firms visited, only *two* had methods not in general use (with slight variations) by the rest of the trade, and only one had an installation and method possessed in its entirety by no other. It is significant, by the way, that this firm is one that offered the greatest difficulty before admission was gained, and is famous the world over for the extreme accuracy and general excellence of all its work.

Another fact brought out was that those firms who refused admission were not up to the standard of the others as regards equipment, methods and product in other departments than the *treating* department. The manager of one of these firms informed me that although I was now an officer in the Government service, *I might not always be.*

In conclusion I desire to lay emphasis upon the fact that I have visited a large number of firms in the East in the last few years and have been treated with the utmost courtesy, even in cases where a refusal would have been fully justified, either on the grounds that the Government was not interested in his line, or was *too deeply* so. It is to be noted that, after visits to the various departments of the larger steel manufacturers, where certain shops are closed against even foremen from other departments of the same works, very few of them seem to possess secrets from each other, so far as manufacturing processes are concerned. How much of this is due to "back-door" entrances, as related by Entropy, I am, of course, unable to state.

Philadelphia, Penn. AN INSPECTOR.

Testing Lubricants

On page 1038 I note a description of a simple method of testing the relative values of different lubricants.

I have had some experience in such ready means of comparison, which makes me feel like warning the readers of your paper that these tests should be run for several days in succession with each oil, and that when changing from one oil to another, it is imperative that the bearing be thoroughly cleaned, so that there shall be no possibility of the two oils mixing in the bearing, so forming a blended lubricant, which would probably give very different results from those which would be obtained from either oil alone in a clean bearing.

The kind of bearing also has a great deal to do with the oil used; that is, if it is a ring-oiling line-shaft bearing, the oil giving best results on it would not probably work as well on a main bearing of a reciprocating engine as some other, which in turn would be quite unsatisfactory for the main bearings of a large electric motor. But, of course, most of your readers understand the necessity for different oils for different sorts of service.

If the test suggested in your article above mentioned, is made on a bearing having drip or sight feed, or any other intermittent form of lubrication, the lubricator should be adjusted to feed the same number of drops per minute in each test, for if one of the oils compared was a thin, fluid oil, and the other heavy and viscous, the thin oil might, unless the lubricator was readjusted, keep the bearing cooler by merely feeding perhaps twice as much oil.

I think an excellent way of comparing the oils, and one which I have tried with satisfactory results is to adjust the oil feed for each oil, to the number of drops per minute which will give a certain rise in temperature, say, the same temperature rise given by the oil in use when the comparison is made; this can be done by a careful man in a short time by trial; and after this adjustment is made, the amount of oil required to keep the test bearing at the required temperature for a week can be determined by simple arithmetic.

Then, if the bearing uses two gallons of the new oil at 50 cents per gallon, per week, that oil will cost $1 per week, while if the old oil kept the bearing at the same temperature with the use of three gallons of oil at 33 cents per gallon, it would cost but 99 cents per week.

In this way the dollars-and-cents relation of the oils under consideration may be obtained directly, and very simply, and after all, that is the point of view that the shop manager or operating engineer is interested in.

R. H. DANFORTH.

U. S. Naval Academy, Annapolis, Md.

How To Do Work

There seems to be misunderstanding in some quarters in regard to the article which appeared on page 1006, Volume 33, Part 2, and in which I suggested that the automobile cylinder shown be taken as a subject for study in the designing of tools and fixtures, as well as the selection of proper machines for doing the work.

Some seem to see a hidden motive, and accuse me of having nefarious designs for securing valuable information for nothing, when, if my article is carefully read it should be plain that I have no such intention.

As a matter of fact, I have absolutely no connection with automobile building in any way, and simply selected the cylinder shown as a modern example of work which would include drilling, boring and grinding, and afford an opportunity for considerable thought regarding economical methods of machine work.

When a man is studying mathematics he does not expect pay for working out the various problems given, even though they might give valuable information to someone in that particular line of work, and he never thinks of the author of the example as attempting to secure something for nothing.

This was given simply as a suggestion for those who desire to become more familiar with machining methods, with the cost of various machines, and with the planning of ways of doing work, as to studying out the best means for the three different productions mentioned, as it is very evident that they require entirely different treatment.

I still believe that this affords one of the best opportunities I know of to secure information which will be valuable in any kind of work, and which will also put a man in the way of securing other information which cannot help being of value to him.

Anything that is worth while doing is very sure to require more or less effort, and it very seldom happens that there is immediate remuneration in sight, but it is safe to say that any man who carefully follows through such a problem as this will be worth more to himself and his employer than the man who waits until someone offers a reward for its solution.

Chicago, Ill. FRANK C. HUDSON.

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American Machinist

Editorial

Hobbed Gears

During the past few months our pages have contained a number of discussions in regard to hobbed gears. Many of these discussions have been lively and animated and we have welcomed them, for the position of the hobbed gear, particularly the hobbed spur gear, is by no means clearly defined as a machine element. Much good can and should follow from such an interchange of opinions.

But speaking of these opinions, many of them have been diametrically opposed to many others; on the one hand the hobbed-gear contour was nothing but a series of flats, on the other hand these flats were round and formed a perfect profile.

Would it not be wise to consider at this time the purpose of the hobbed gear and endeavor to establish its limitations? Such a course would be really constructive. It is not fair to suppose that the hobbed gear is like a patent medicine and is capable of curing all gearing troubles in the way that the cure-all is guaranteed to alleviate all human ills. The superiority of the gear cut with a circular cutter over a cast gear cannot be gainsaid. Thousands of cast gears are used today, a prominent illustration being in textile machinery. Yet no one thinks less of circular-cutter made gears because they are not used on textile machinery, neither do we condemn gears with cast teeth in a wholesale manner, for we know that there are many places where they function with satisfaction.

There are limitations to any kind of a gear, and to repeat our question, is it not wise at this time to consider the limitations of the hobbed gear—for such limitations undoubtedly exist—and by so doing build up a constructive knowledge of them and their uses?

Educating Employees

We believe that everyone who is at all interested in industrial education will be well repaid to read and reflect upon the paper by Dexter C. Buel, on "Railroad Education" which appeared in a recent issue. The plan he outlines, which is being followed by the Union Pacific Railroad, has much to recommend it and that it can be followed to some extent in almost every line of work.

As it is not compulsory, it shows very plainly which of the employees are ambitious enough to desire education and advancement, while the preparing of special pamphlets which are distributed to all employees, whether students or not, is sure to interest many who have not already joined the classes. In this same connection, the plan for preparing special pamphlets on one particular subject, such as square root, which will enable the student to grasp all the mathematics necessary in his particular course is to be highly commended. It is infinitely better than the plans formerly followed by correspondence schools of compelling a student to wade through page after page of mathematics with the result of often becoming discouraged before he reached the point where he saw its practical application.

The provision for allowing men to take up other branches of railroading, instead of endeavoring to keep them always in the same department, is also to be commended for its broadmindedness. The mere fact that a man can study the work of different departments relieves him of the feeling that he is being kept in a rut and that any branch of the service is open to him when he qualifies for it. We believe this is of great benefit to the railroad, as there can be no question as to the advantage in having the men of one department more or less familiar with the work of the others.

When it becomes generally known that the employees of any organization can prepare themselves to fill better positions, and that they will be helped to do so by their employers, it cannot fail to add to the loyalty and feeling of mutual helpfulness which is so essential to the smooth running of any business.

While a large railroad organization has many advantages over the ordinary manufacturing plant, both in the number of men to be trained and in the variety of work in which they are engaged, a comparatively small plant can find points of value which can be adopted and which will aid in the better understanding which is so necessary to success. Any plan which can even in a small measure, do away with the feeling of separateness, which is all too prevalent at the present day, cannot fail to be of benefit in the solution of the ever present problem.

Remarkable Move of the German Machine Industry

As we hear from our German office, 20 German machine manufacturers have combined to establish central offices for the Far East in Shanghai. These offices are divided into different departments, each acting for a special line represented in the combination. A German engineer, who has been a resident of China for more than 10 years and knows the country and the Far East thoroughly, is at the head of these offices.

The chief object of these offices will be to negotiate with customers and prospective customers and to carry on negotiations independently of the home establishments, up to completion. By avoiding troublesome correspondence and communication with the home establishment, the office will be enabled to act quicker and presumably with more success, for their principals, than other houses represented by export firms only, could be.

The combination comprises a large German ship-building firm, a firm known as the Bamag concern, who are manufacturers in a large way of colliery machinery, gas works and the like, a Dresden firm making grinding mills and the two well known machine-tool firms Reinecker and Scheiss, Düsseldorf. The whole cost of the offices is only estimated at £5000 a year. As this cost is borne by 20 firms, the individual expenses are quite low compared with the advantages offered.

New Publications

Edison—His Life and Inventions.. By Frank L. Dyer and T. C. Martin. Two volumes, comprising 988 5¼x8-inch pages. Harper and Brothers, New York and London.

The world is not favored with many lives of great inventors, and, it is not too much to say, it is favored with none equal to this. The story to be told is a great one and the manner of the telling is worthy of the opportunity. There are few more moving pictures than the account of Edison's boyhood, with its ceaseless activities and its marvelous originality. No boy ever showed the metal that was in him earlier or more thoroughly than Edison, and, from the standpoint of human interest alone, there are few pieces of biographical literature of such absorbing interest as this.

The story of Edison's later years and of the marvelous procession of inventions that came from him is told in the same sympathetic, personal way, and is only less interesting because the boyhood of a genius must always be the most interesting portion of his life.

And apart from the above considerations, it is well that a permanent record has been made of the origin of the great inventions that have come from Edison's brain. It is the constant complaint of those in industrial life that formal history neglects to record the real progress of social and material development. Certainly a life which has originated or largely developed such inventions as the stock ticker, the quadruplex telegraph, the telephone, microphone, phonograph, kinetescope, incandescent lamp, electric lighting as a system and the electric railway—to go no further into the list of 2500 inventions which have been protected by patents and caveats—is entitled to a record.

The work would have been incomplete without adequate explanations of Edison's more important inventions, and in order to prevent interruptions in the personal narrative and at the same time divest this latter of descriptions which must be, to a certain extent, technical, the descriptions are grouped together in an appendix to the second volume, and following this comes a chronological list of Edison's patents.

Either of two motives may lead to the beginning of the reading of these volumes—interest in the life of their subject as such, or the desire for entertainment through an interesting story—but it is safe to say that whichever motive leads to the beginning of the reading, the conclusion will be the result of both.

Foreign Tariff Notes

The initial number of a publication entitled "Foreign Tariff Notes" has just been issued by the Bureau of Manufacturers of the Department of Commerce and Labor. The scope of the new publication is a broad one, embracing changes in rates of import and export duty in all the important countries of the world; notice of proposed or pending revisions of foreign tariffs is also given, together with amendments of the customs and consular regulations.

The first number covers the changes for the last five months; the separate items it contains have appeared from time to time in the *Daily Consular and Trade Reports* since July, and are now reprinted for greater convenience of reference. A special chapter describes the regulations governing the admission of automobiles in several countries. Future issues of "Foreign Tariff Notes" will be published as often as the number of items requires.

Personals*

A. A. Ball, well known as a designer and inventor, is now located in New York City with the Single Service Package Corporation of America.

C. W. Beaver, of the Yale & Towne Manufacturing Company, sailed on December 28 for a trip through Europe in the interests of his company.

H. P. Porter, formerly a member of the engineering firm of Schlafle & Porter Company, Houston, Texas, has become chief engineer of the Cerro de Pasco Mining Company, La Fundicion, Peru.

Wilbur N. Sar Vant, formerly engaged in electrical contracting in New York City, has accepted the position of assistant chief engineer of the Standard Turpentine Company of Florida, Jacksonville, Fla.

Paul Froiland, formerly general foreman of the Lycoming Foundry and Machine Company, Williamsport, Penn., has accepted the position as superintendent of the Boston Gear Works, Norfolk Downs, Quincy, Mass.

Frank A. Hazard, for the past two years mechanical engineer for the Automatic Platen Press Company, New York, has resigned his position in order to engage in the design and construction of special printing machinery.

J. W. Carrel, general sales manager of the Lodge & Shipley Machine Tool Company, Cincinnati, Ohio, will sail on January 5 for a four months' European trip in the interests of that company. Mr. Carrel will be accompanied by Mrs. Carrel.

Ernest W. Duston has accepted the position of chief draftsman with the machinery division of the Blake & Johnson Company, Waterbury, Conn., previous to which he was connected with the Russell, Burdsall & Ward Bolt and Nut Company, Port Chester, N. Y.

C. C. Taylor, formerly works manager of the Remington Arms Company, has been appointed to the newly created office of general manager of works and in future will have charge of the general administration and operation of the Remington Arms Company, of Ilion, N. Y., and of the Union Metallic Cartridge Company, of Bridgeport, Conn.

*Items for this column are solicited.

Obituary

Matthew Kennedy, treasurer of the Kennedy Valve Manufacturing Company, Elmira, N. Y., died in that city on November 26, 1910.

Walter L. Pierce, who for 32 years had been connected with the Lidgerwood Manufacturing Company, New York, died on December 10, at which time he was 55 years of age. Mr. Pierce was known to a wide circle of business friends, and had come to be looked upon by them as a man possessing exceptional executive ability, as well as an engaging personality. He was a member of the American Society of Mechanical Engineers, Naval Architects and Marine Engineers, and a past president of the National Metal Trades' Association.

New Tools and Shop Appliances

A Large Spur Gear Cutter

The halftone shows an automatic spur gear cutting machine, manufactured by the Newark Gear Cutting Machine Company, Newark, N. J. The machine has a capacity for gears up to 84 inches diameter, 24 inches face, and 6 inches circular pitch.

The machine is driven by a single pulley, running at a constant speed of 300 revolutions per minute.

The cutter spindle is provided with a taper hole to receive cutter arbors which are drawn into and forced out of the spindle, by means of a draw-in bolt. The spindle and arbor are amply heavy to secure the benefits of using a gang of finishing cutters, or a gang of finishing and roughing cutters side by side on the arbor. The spindle is driven by means of a powerful squr-gear train. The various speed changes are obtained by means of change gears placed as near the last driver as possible. This allows the driving shafts to rotate at constant speed, and avoids undue strains in the shafts when the cutter is running at slow speed on heavy pitches.

The changes of the feed of the cutter carriage are obtained in similar manner, by means of change gears; but the rate of the cutter speed and the rate of the carriage feed are independent of each other, so that one may be changed without affecting the other. The carriage quick return is constant, not being affected by the feed or speed of the cutter. The carriage feed screw is under tension when in action the thrust collars being placed so that the screw is not subjected to compression strains, either when feeding or returning the carriage. This draw-cut insures a smooth uniform feed to the carriage free from vibration.

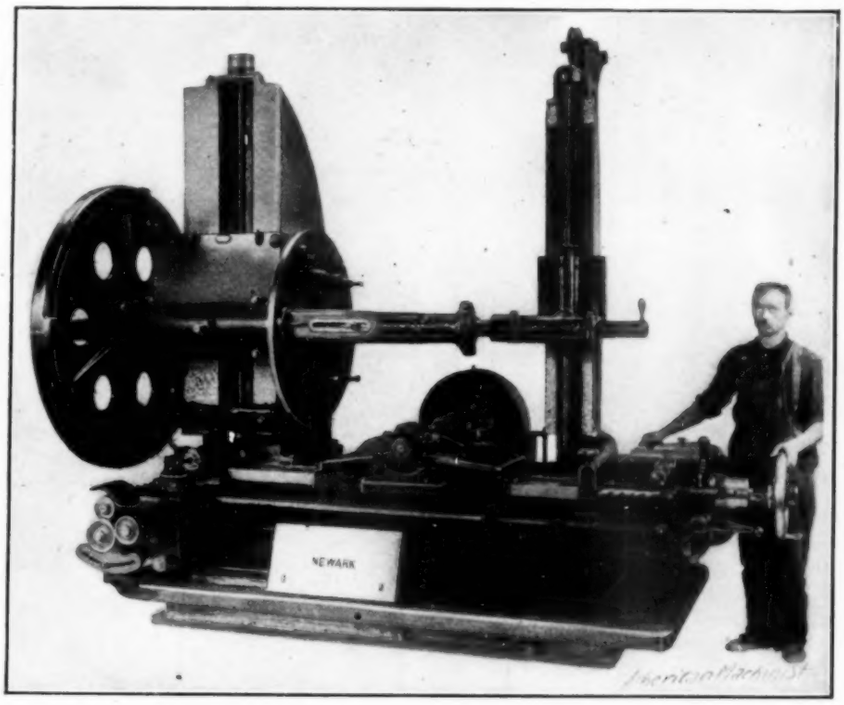
The indexing or dividing mechanism comprises a large master wheel, and positive actuating mechanism. The master wheel is a worm wheel, generated in place on each machine. It is made in sections, that is, a wheel proper, and a ring; this construction being used to insure accuracy not otherwise obtainable. The master wheel receives its movement through the positive indexing mechanism, which embodies a very simple clutch mechanism, requiring no adjustment. The various divisions for different numbers of teeth are obtained by means of change gears, which provide for cutting all numbers of teeth up to 100, and all from 100 to 450 except prime numbers above 100. A wide range of higher numbers can also be cut. Where any unusual number is required to be cut, this can be done by means of an extra change gear.

In connection with the positive indexing mechanism, is a safety device, which prevents the carriage from feeding until the division has been correctly completed. This is especially valuable when it is considered that the machine cuts very large and expensive gears. A safety mechanism also acts to prevent the machine from dividing when an obstruction on the gear blank, such as a lug or flange, would collide with the rim support, and otherwise, if it were not for the safety device, injure the gear or the machine.

The operating levers are placed on the operating side of the machine, so that they are instantly under the control of the operator.

ANY and all new or improved machines, tools, or shop appliances of interest to men responsible for results in machinery-making plants will be briefly illustrated and described here—the machine shop news.

A more full and detailed description will be given—when it is real news—if it can appear here first—before it is sent to other papers. All descriptions appear in ALL four editions of the paper—Weekly, Monthly, Weekly English and Weekly German.



A Large Spur Gear Cutter

A New Brown & Sharpe Plain Milling Machine

The halftones show a new No. 13 B plain milling machine, which has just been brought out by the Brown & Sharpe Manufacturing Company, Providence, Rhode Island.

It is a machine of the constant-speed drive type, adapted to modern manufacturing methods and the production of duplicate parts.

Any standard constant-speed motor can be employed to drive it.

The upright which supports the spindle head is of box form and the bed and saddle are constructed so as to give the maximum support to the table when under heavy cuts. The saddle is long, wide and heavy, affords ample bearing for the

table, and itself has large bearing surfaces on the bed.

The single pulley, 14 inches in diameter, 4½ inches wide, and running at a speed of 3000 revolutions per minute, gives a very powerful and efficient drive and permits the machine to be driven direct from the main line, if so desired. No countershaft is regularly furnished.

The machine is convenient to operate and all levers and handwheels for changing speeds and feeds are within easy reach of the operator.

The spindle is heavy, of crucible steel with large bearings accurately ground and correctly proportioned to withstand heavy service. It has a standard taper hole, the front end is threaded to receive a chuck or large cutter and has a recess across for driving an arbor or collet with clutch collar. A draw-in bolt is also furnished for holding arbors, etc., in place.

The spindle boxes are heavy and provided with means of compensation for wear; they are made of phosphor bronze which has been found best suited for the requirements of the machine.

A friction clutch is located in the driving pulley and provides means for starting and stopping the machine. It is operated by a lever *A*, Fig. 1. Power is transmitted from the pulley *D*, Fig. 2, by means of bevel gears and shafts to the gear box *E*, and by bevel gears on the shaft *H* to the vertical shaft *F*, which drives the spindle through the worm and worm gear *G*.

The worm is of hardened steel and the worm gear of bronze and run immersed in oil. The shaft *F* carrying the worm is mounted eccentrically in its bearings so that back lash between the worm and gear can readily be corrected by adjusting the eccentric bearings. The worm is also provided with a ball thrust adjustable to take up wear.

The table is heavy and sufficiently deep to rigidly support work to its full capacity. The T-slots are deep to insure strength. The feed to the table is from the gear box *E*, through the universal shaft *H* and worm and wormwheel *I* and *J* connecting with table rack and pinion. Eight changes of feeds are provided from ¾ to 9 inches per minute. Quick return is obtained by means of the handwheel *B*, Fig. 1. The handwheel controls both the longitudinal and transverse feeds; an entirely new feature. Normally the handwheel is used to operate the longitudinal feed but when the operator wishes to adjust the table transversely the handwheel is pushed in thereby disengaging a clutch and engaging a gear located on the screw which controls the transverse adjustment which is 6 inches. The longitudinal feed of the table is 34 inches, positive and automatic in either direction and can be automatically released at any point.

The variations of both spindle speeds and table feeds are obtained by means of change gears which are kept in a wooden box in the base of the machine. The gear case is shown open in Fig. 2. The tables of speeds and feeds, together with the directions for making the changes, are cast in the cover to the case. The change gears for changing speeds are held in place by clutched hubs and split washers and can be readily removed without removing the nuts.

A vertical adjustment of 12 inches is provided which is operated by the handwheel on top of the upright. This handwheel is graduated to thousandths of an inch. The spindle head slides in ways and is clamped rigidly to the upright by bolts.

The overhanging arm is a solid steel bar ground round and true, and can be pushed back when not in use.

The arbor support can be used at any intermediate point near the cutter. It has a bronze bushing for outer bearing of arbor and an adjustable center.

In addition to the graduation on the handwheel operating the vertical adjustment a dial graduated to thousandths of an inch indicates the transverse adjustments.

The base is amply heavy to insure rigidity and rests on two legs and a pedestal. It has an oil rim to catch waste oil and a tank providing for an ample

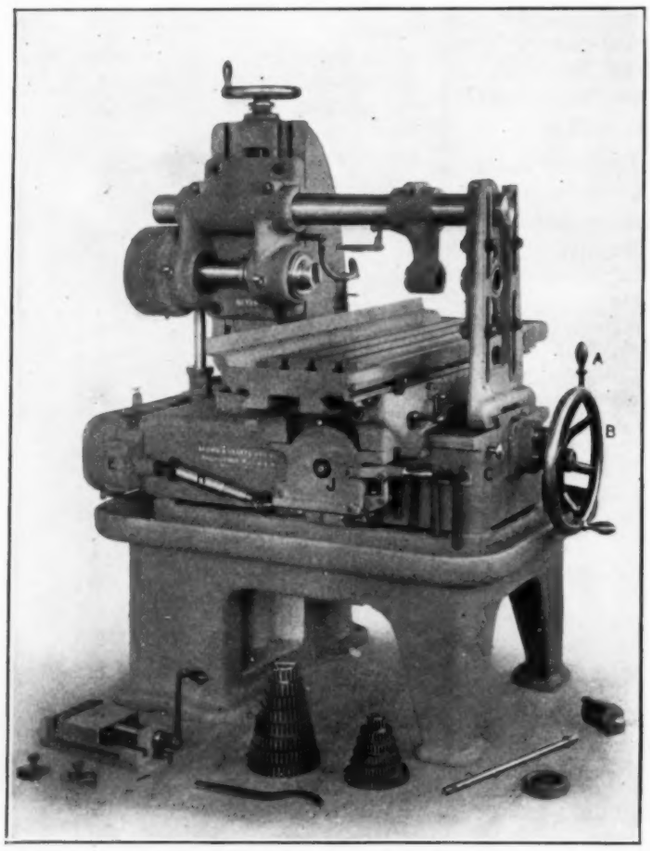


FIG. 1. PLAIN MILLING MACHINE: FRONT VIEW

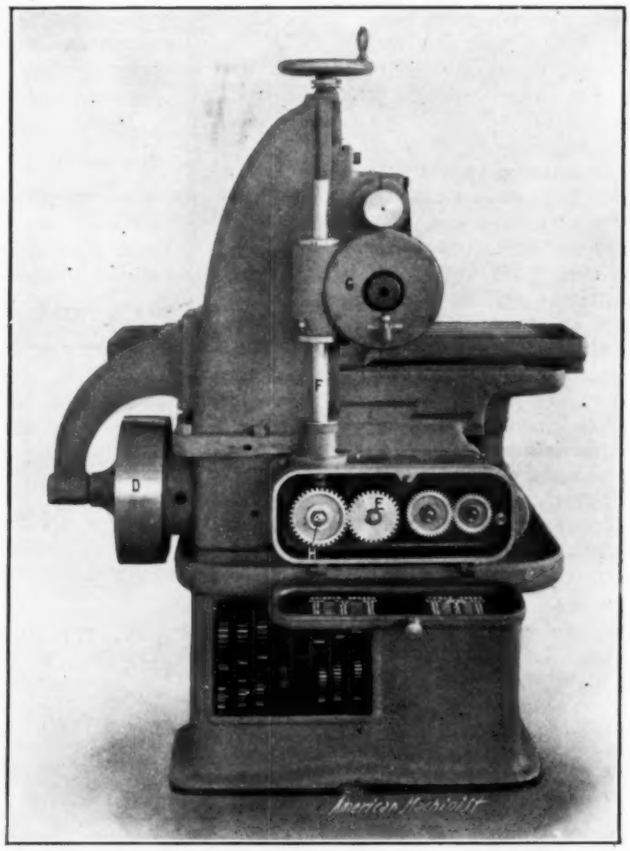


FIG. 2. REAR VIEW SHOWING CHANGE GEARS AND DRIVE

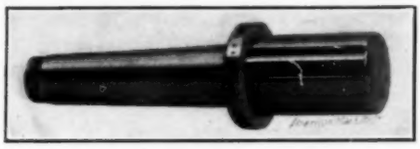
supply of lubricant. The bed has unusually wide ways for the saddle.

Special provision is made for an ample supply of cutter lubricant. The channels in the table and saddle are extra large. A pump is furnished.

Roll Grip Mandrels

A simple and rather ingenious mandrel of useful application is illustrated herewith, in which it will be noted that a roll is inserted, so set as to grip the work in a positive manner.

For such work as gear blanks, collars,



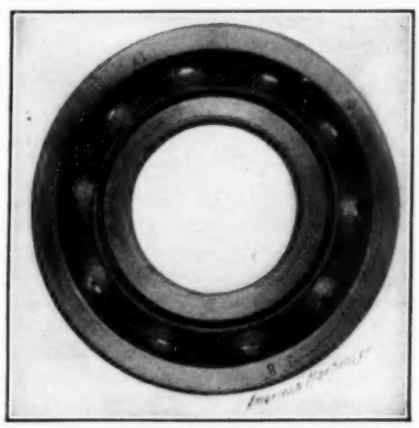
ROLL GRIP MANDREL

bushings, pulleys, etc., it will be readily noted that this form of mandrel has a useful purpose, eliminating the need of the tailstock on small work, and permitting the setting up of such work with the minimum of delay.

In machining work to lengths these mandrels have the advantage of allowing the cutting tool to cut clear across. They are manufactured in all sizes from high-grade steel, hardened and ground, and are a recent product of the Jaeger & Sword Manufacturing Company, Millbrook, N. Y.

A Ball Bearing

The halftone shows a ball bearing which, while new in this country, has been in use in Europe for some years.



IMPORTED BALL BEARING

It is handled here by Marburg Brothers, Thoroughfare building, New York.

These bearings are made of high-grade steel subjected to special treatment which renders it exceptionaly hard and tough. The races are accurately ground all over and are guaranteed true to size within a limit of 0.002 inch.

The cage consists of two pressed-steel rings L-shaped in section except where they are formed for the reception of the balls. These are riveted together with brass rivets. When riveted together the two L's form a T-section, which makes a very strong cage, which cannot work loose. Besides its use as a spacer for the balls the cage lifts the lubricant from the bottom of the bearing and carries it to the top from whence it again flows to the bottom by gravity.

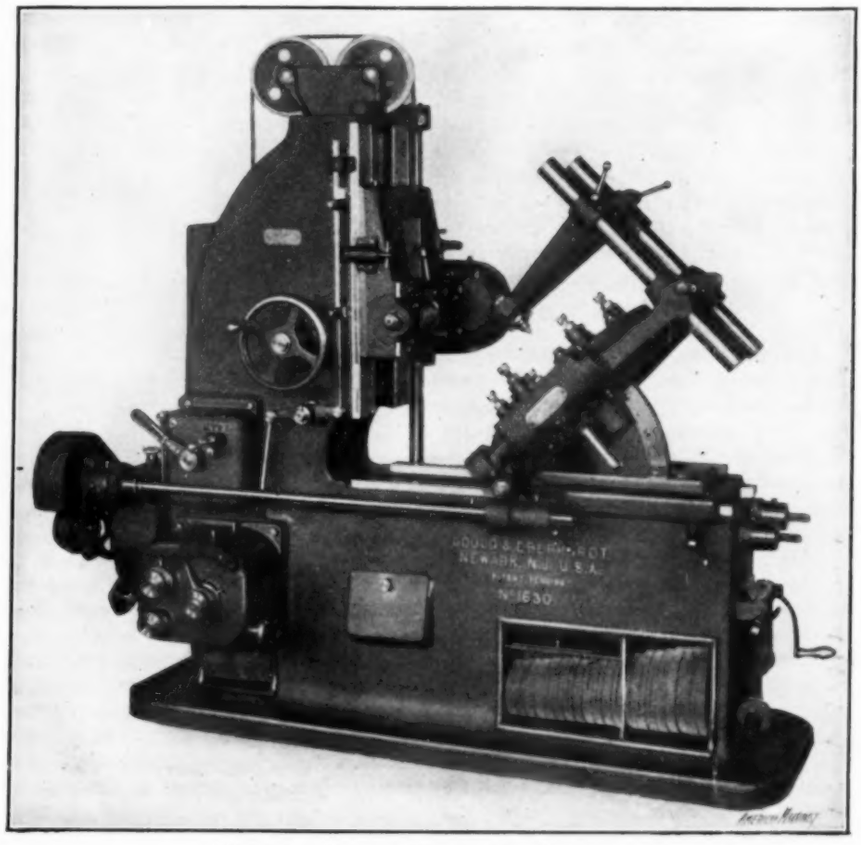
These bearings are also made with double rows of balls.

Automatic Gear Cutting Machine

The halftone shows a new machine manufactured by Gould & Eberhardt, Newark, N. J., for cutting spur, bevel and face gears; and for roughing out automobile bevel gears. The machine has a capacity of cutting 36 inches in diameter and 10 inches face spur gears, and 24 inches in diameter and 8 inches face bevel gears, both up to 3 diametral pitch in cast iron and 4 diametral pitch in steel.

The cutter slide moves in a vertical plane. The feed arrangement is of the draw-cut principle; there being a separate and direct drive to the feed-screw mechanism. This vertical cutting feature eliminates the disadvantage when cutting bevel gears, of tilting the cutter slide with all its many moving parts.

The work table is adjustable to any angle and is so mounted that all the strains imparted by the cutter are taken by the main base of the machine. When the table is in this angular position it is supported by a segment arranged centrally and provided with a worm wheel sector, whereby the table is adjusted. In addition to the sector, a strap in the segment makes a rigid lock for the table when adjusted. A crank handle on the front end of the machine enables the operator to adjust the work table by degrees and minutes. The last mover of the indexing train is a large diameter worm wheel, arranged to be close to and rigidly secured with the work table. A trianguar outer support supports the work mandrel in any angular position. The feed is controlled by a variable-feed direct-reading gear box, which provides 16 different feeds ranging in a geometric progression from 1 inch to 15½ inches. The cutter slide is counterbalanced and is provided with a rapid return. The cutter is driven by a steel worm and bronze worm wheel of special construction, which insures a smooth running and powerful drive. There is a solid cutter arbor made of chrome nickel steel, which can accommodate different size bushings for the various holes of cutters. A number of speeds to the cutter from 23 to 145 revolutions per minute, arranged in geometric progression, are obtainable by means of change gears furnished. There is only one driving pulley for the running of the entire



VERTICAL CUTTING TYPE OF GEAR CUTTER

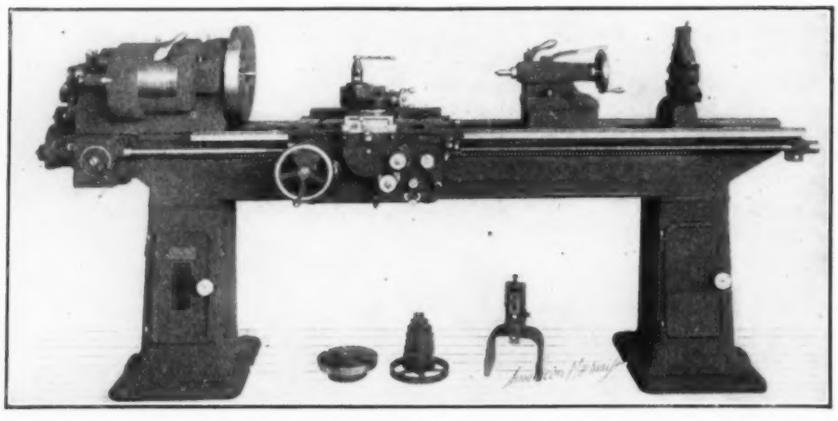
mechanism of the machine, and all gears are entirely inclosed with guards.

The machine weighs 3300 pounds, and may be furnished with motor drive.

Geared Head Lathe

The accompanying halftone shows the latest type of Schellenach geared-head lathe manufactured by the John B. Morris Machine Tool Company of Cincinnati, Ohio.

The cut shows their standard 16-inch by 8-foot lathe, arranged with semi-quick change gear box. This gear box is made to interchange with the quick-change screw-cutting attachment and either the semi-quick change gear box or the quick-change screw-cutting attachment may be applied by the purchaser at any time after the machine leaves the factory, should a change be desired. The semi-quick change gear box provides three changes of feed for every change of gears and it will be noted by referring to the cut, that the change-gear quadrant is mounted upon, and swings directly from, the gear box, thus permitting this part to be manufactured as an independent unit.



SCHELLENACH TYPE GEARED-HEAD LATHE

The apron feed is through a splined screw and a steel, sliding, double-bevel pinion. Both cross and longitudinal feeds are driven through frictions and are reversible in the apron. A positive feed is provided which permits of the use of the rack for rough chasing of all screw pitches shown in the index, thereby relieving the lead screw of excessive wear. Means are provided for disengaging the rack pinion from the rack; also an adjustment of the rack pinion to compensate for wear.

An eccentric lever at the right end of the apron enables the operator to lock the carriage quickly to the bed for facing. The chasing indicator is located at the right end of the carriage, and is made so that its worm wheel may be swung out of engagement with the threads of the lead screw when not in use. The apron hand-wheel, as well as that of the tail-stock, is counterbalanced. The steady rest is arranged to be faced in either direction. The index plate provides a list of diameters to be turned at various cutting speeds in feet per minute, and these diameters, of course, correspond to the various gear combinations of the driving train.

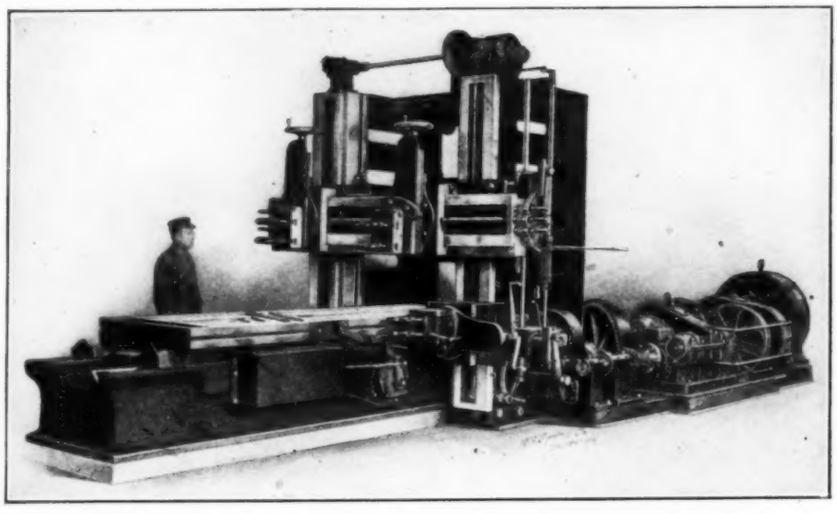
The headstock shown provides fourteen changes of speed when running the driving pulley at a constant speed. The design permits of an oil bath for the gears and all of the gears which are thrown in and out of engagement are made of nickel steel and are hardened. All speed changes, whether in back gear or out of back gear, may be made while the machine is running. There are no loose gears and no gears are exposed.

When supplying this machine with motor drive, a bracket is mounted upon the headstock and a gear is provided in place of the pulley. The lathe is also arranged so that the drive may be by silent chain driven from the motor mounted underneath the headstock. This style of headstock is also built in 18- and 20-inch sizes.

Heavy Duty Double Housing Forge Planer

The accompanying halftone shows a new extra heavy duty double-housing forge planer recently developed by the Detrick & Harvey Machine Company, Baltimore, Md., which incorporates a new induction drive, developed by the Wheeling Mold and Foundry Company, capable of furnishing variable cutting speeds from 35 to 50 feet, and the return speeds from 65 to 100 feet. An important point in connection with the operation of this drive is the fact that the cutting and return speeds can be changed quickly and independently of each other. The planer illustrated is driven by a 50-horsepower motor.

Obviously the planer is constructed for extra heavy work. The 48-inch pattern machine planes 50 inches wide by 48 inches high. The table is 43 inches wide and 12 inches deep over the ways, and has one flat and one V way. The bed is 22 inches deep and has three vertical ribs of metal its entire length. The cheeks for the housings have a vertical depth of 32 inches, and are 55 inches long. As will be noted the housings are of rectangular box shape with faces 16¼ inches wide, being secured at the top by a tie extending from the front to the rear, a construction making for extreme rigidity. The crossrail has a vertical face of 19 inches and a depth of 20 inches, and is raised and lowered by an independent motor.



HEAVY-DUTY FORGE PLANER

The two heavy pattern heads have steel aprons and holders. All the gearing, except the driving worm (Sellers drive) which is made of phosphor bronze is of steel and is cut from the solid. The driving worm has six teeth in engagement with the table rack of nine inches face. The rack is of steel cut from solid forged bars.

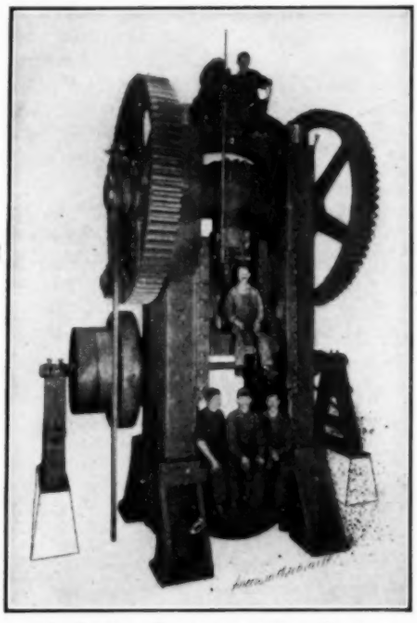
An idea of the machine's construction can be obtained from the weight of the 48-inch by 10-foot type—53,000 pounds exclusive of the motor and induction drive. The table weighs 9100 pounds, the bed 14,500 pounds and the cross rail 3800 pounds.

The machine can also be furnished by the makers for belt drive from line shaft or from belt connected-motor.

A Large Straight Sided Press

The halftone shows a straight-sided single-crank press recently built by the E. W. Bliss Company, Brooklyn, N. Y. It is the largest press of this type as yet built by this company.

The press is of the built-up type of construction, in which four large vertical tie rods receive all the strain relieving the frame columns of the pressure exerted in operation. The frame columns are of heavy cross-section, imparting great rigidity to the entire press. The



A LARGE STRAIGHT-SIDED PRESS

crank shaft is 16 inches in diameter and weighs 9500 pounds. Power is transmitted to it at both ends. This greatly reduces the torsional or bending strain on the shaft and equalizes the pressure on the journals and gears. The slide, which is guided practically its entire length in the gibs when the tools are doing their work, is owing to its great size and weight, raised or lowered by a 4-horsepower motor mounted on the top of the press, power being transmitted from the motor to the worm and worm-wheel adjustment through a vertical shaft fitted with knuckle joints.

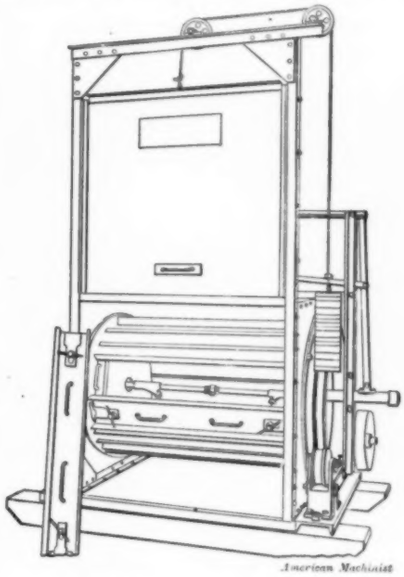
The machine is triple geared and the entire train is made up of cut-steel gears and pinions, the large main gears each weighing about 13,000 pounds.

The machine is controlled by a hand lever operating a powerful friction clutch, designed especially for heavy duty. By means of this clutch the machine is always under instant control and may be stopped and started at any point of the stroke. Attached to the wheel is a safety coupling as a safety guard in case the press through carelessness or otherwise is subjected to a pressure greatly in excess of that for which it is designed. The total weight of the press is 190,000 pounds.

The Ohio Sand Blast Tumbling Barrel

This machine is made to clean small, or other, castings in quantity without injury or defacement of the sharp edges, angles and surfaces thereof.

The barrel, which rests on four trunions made with roller bearings, is revolved slowly by power, three revolutions per minute being ample to expose all surfaces to be cleaned to the action of the sand blast, which is carried into the barrel through two horizontal pipes, terminating in nozzle holders with renewable jets, which are swung mechanically across the line of revolution of the barrel, at a speed sufficient to cover all of the articles to be cleaned.



SAND BLAST TUMBLER

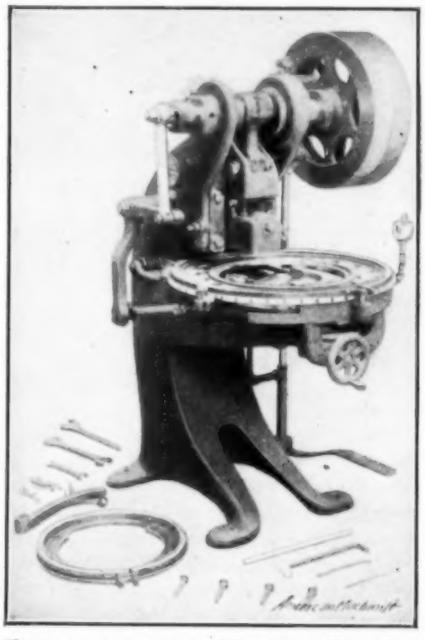
The barrel is made of two end castings upon which are bolted steel staves, so spaced that the sand escapes through the openings between them. The staves can be easily renewed at small cost, being made of standard merchantable shapes.

With air pressure from 20 down to 10 pounds brass castings were cleaned in this form of barrel at the rate of 250 to 300 pounds in 10 minutes, without defacing their surfaces in any way.

These barrels are made in several sizes by J. M. Betton, 178 Washington street, New York and the J. D. Smith Foundry Supply Company, Cleveland, Ohio.

Ferracute Internal Notching Press

The halftone shows a type C 82 press, built by the Ferracute Machine Company, Bridgeton, N. J., for notching internal work, such as field laminations. The press proper is the same as that used for external notching, the external carriage with its spindle, spider, pawl lever and other appurtenances being removed and the larger carriage shown substituting therefor. Upon this is mounted a ring, known as the ratchet holder running in adjustable bearings. Within this, doweled to it, can be placed any desired disk holder, which consists of another ring with the internal diameter of its upwardly projecting flange fitted to the outside of the disk to be notched. Attached to this carriage is a pawl lever, which is driven by the same pitman (swiveled to the rock shaft at the left of the machine), which drives the pawl lever for external work. As many parts as possible, including the lock lever and lock, are used interchangeably in both forms of machine.



FERRACUTE INTERNAL NOTCHING MACHINE

For disks having an inside diameter from 3 to 12 inches, with an outside diameter from 6 to 15 inches, a small sized ratchet holder is used. This will receive the 18-inch ratchets, which are used upon the spider of the external machine.

For disks with an outside diameter of from 15 to 24 inches, a large sized ratchet holder is used. One of these is shown upon the floor, with its brake mounted upon its outside, and the adjustable gib upon which it is revolved shown inside it. On the floor is also shown the special pawl lever for internal work.

Machine Recording Instrument

The new line of curve-drawing instruments which have recently been put on the market by the General Electric Company adapt themselves very readily to permanent or temporary installation for obtaining information on motor-driven machines, one of which is shown in the

MACHING-RECORDING INSTRUMENT

accompanying illustration applied to a shaper.

These instruments are well designed both electrically and mechanically and so constructed as to maintain their accuracy under all ordinary conditions of service.

The internal parts consist of the clock mechanism, the measuring element, and a damping device. The spindle carrying the pen arm has cylindrical pivots and runs in ringstone endstone jewels, thus keeping the pen always in correct alinement.

The electrical element is of the solenoid type with gravity control, insuring a durable instrument which can be operated on either A. C. or D. C.

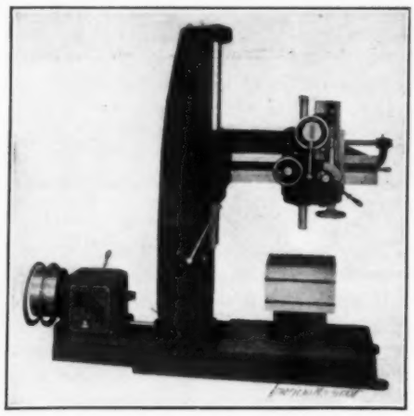
The clock is a high-grade movement with marine escapement and, with ordinary chart speeds, will run two days with one winding.

From the records made by these instruments it is possible to gain much information, such as the exact number of hours the machine has been operated, both running light and loaded, the time required to remove a finished piece of work and start another, the condition of the motor and tools, and the correct size of a motor to use with a new machine.

Improved Gang Radial Drill

Simplicity of all the movements in the new radial drill illustrated herewith, the latest product of the William E. Gang Company, Cincinnati, O., has been given special attention. The general construction makes for rigidity and durability, all gears being inclosed as the result of the design.

The spindle is driven at the lowest point in its largest diameter close down



IMPROVED GANG RADIAL DRILL

to the work. It is provided with a reverse motion for tapping and is counterbalanced by a rather unusual arrangement. There are 12 changes of speeds, ranging from 39 to 280 revolutions per minute, suitable for drills ranging from

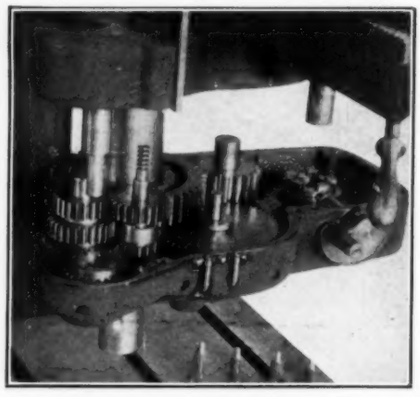


FIG. 2. HEAD COVER REMOVED, SHOWING FEED AND BACK GEARS

$\frac{1}{8}$ inch to $2\frac{1}{4}$ inches in cast iron, and from $\frac{3}{8}$ inch to 2 inches in steel.

The speed box is of a type which consists essentially of a cone of six gears and a lever carrying a tumbler gear which transmits the power from the constant-speed pulley shaft to the cone of gears. This tumbler gear acts without shock or jar. A tight and loose pulley is provided on the machine so it can be driven direct from the line shaft, and by the use of band-shifter rings, the belt can be delivered to the pulleys at any angle. The column revolves upon a stationary stump, having a bearing at the top and bottom, giving practically a double column. The weight is taken on a roller thrust bearing, allowing the column to swing freely and is securely clamped by the slight movement of a lever that lifts the column away from the rollers so they cannot become imbedded in their race.

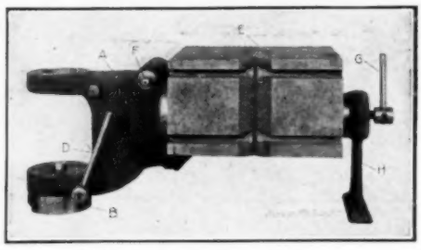
The arm is of "D" section heavily webbed, and is raised and lowered by power under control of a lever at the top of the column. The head is adjusted on the arm by rack and pinion, actuated by a hand wheel, and is clamped by a lever on the front of the head.

The back gears are located on the head between the friction reversing clutch and the spindle, and consist essentially of a square-tooth clutch actuated by a lever at the side of the head, and a pair of gears. The lever is indexed by a spring plunger for either one of its two positions. The feeds are six in number ranging from 0.007 inch to 0.036 inch per revolution of the spindle. The automatic trip operates at as many different depths as there are holes to be drilled, incidentally leaving the spindle free to be moved up or down irrespective of the position of the tripping dogs. It also automatically trips the feed when the spindle reaches the limit of its movement.

Worm Swiveling Table

The accompanying halftone shows a worm-swiveling table manufactured by the John B. Morris Machine Tool Company, of Cincinnati, Ohio, and is supplied as an attachment to its line of plain radial drills.

The upper lug of forked-shaped casting *A* is bored to fit on to and is supported by the lower end of the column of the radial drill. The lower end of *A* is supported on the plug *B*, which is doweled and bolted to the base of the machine in correct alinement with the column. That portion of casting *A* which bears upon the column of the radial and plug *B* is made in halves and is bolted



WORM-SWIVELING TABLE

together and the stud and lever *D* clamp *A* from swinging with the column. The box table *E* swivels upon *A* and is adjusted by a worm formed upon *F*, which worm engages a worm wheel secured to the box table. A circular portion of the table is graduated from both sides of zero to 90 degrees. This swiveling table has a V planed in one side for convenience in clamping cylindrical work. The top of the table is bored in the middle to receive a circular revolving table when this is required. The swiveling table may be securely locked after setting by the clamp handle *G*. The stand *H* bears upon the base of the machine and prevents the outer end of the table from deflecting when heavy strains are imposed upon it.

Some Notes on German Industries

By L. C. Sharp *

An experience in building can-making machinery in Germany, suggesting the basis of German industry. A suggestion for educational bureaus to help foreign trade.

*Proprietor, Omaha Machine Works, Omaha, Neb.

On page 983 I notice an editorial relative to imports of German metal-working tools. I regret that the editor has not seen fit to display this matter in double-leaded type on the front page. Perhaps this matter has been emphasized more forcibly to me from the fact that I worked for two years in one of the large German machine shops building a line of can-making machines of my own invention. I had my overalls on and worked with about 17 men in the most German kind of German atmosphere. This gave me an excellent opportunity to study the ethics of German success in the manufacture of tools and machinery.

In November, 1907, I went to the Canners Convention at Buffalo, N. Y. Among the sight-seers I chanced to meet a young German gentleman who had just come to America in order to find out what was new in can-making lines. We drifted together. At that time I had a new line of machines in mind which I had been unable to develop through failure to interest any American manufacturer. After explaining the merits of my ideas to my German friend he suggested that I accompany him to Germany and use the facilities of his factory in building the machines. He agreed to pay all expenses and to receive therefor an interest in the patents which we hoped to secure. These machines were connected with the manufacture of the open-top, or sanitary can, as now called, the success of which was questionable at that date.

I accepted my new-found friend's invitation, and in three days I was aboard the steamer "America" bound for central Germany. In 11 days we landed at Cuxhaven, after a pleasant voyage much to my surprise. As I could not speak a word of German I kept pretty close to my friend; but this deficiency I was informed was the best of my capital stock in that country. I passed the custom house inspectors with merely a glance at my grip and a wave of the hand on their part, and at the sound of a dinner-bell was informed that our train was ready. We were soon rolling toward the middle of Germany. After sun-down we arrived at our destination and soon after I was tucked away to sleep between a big feather tick on top and a similar feather tick beneath me. The next morning work began.

Building Can-making Machines in Germany

This factory employed from 500 to 700 men on a diversity of work, manufacturing tin cans, sewing machines, and other machinery. It was considered a first-class factory in every respect. I was assigned a suite of rooms over the the factory proper, with a bed and drawing board. As soon as the drawings were complete I followed them through all of the manufacturing departments. Our principal machine was a body maker, for forming can bodies and side soldering them. In this factory all work of this kind was done by hand, requiring the services of about 100 men. Our machine was expected to do all of this work with one man; this we accomplished.

In due course of time I sold my patents and got my money; patent applications were filed in 15 countries. Since that time this firm has abandoned the sewing-machine business and now builds the machines for which I laid the foundation. They have also erected a large factory in California to make cans according to that system.

Before leaving there I made two machines which in this country would sell for $5000. I will not state what they cost me, but they were experimental and of the most expensive kind of work, as all new machines are. I had these machines built, paid 40 per cent. duty on them, and they were delivered in Chicago for less than one-half what they would have cost if made in the United States.

Basis of German Industry

It is difficult to explain just how this can be done; but after a careful study of the industrial conditions of Germany, I have hesitated to enter into a manufacturing business again in the United States. The real social atmosphere of Germany is something that cannot be appreciated at all, if one merely looks at it from a cozy chair in a hotel lobby or from the windows of a railroad car. The whole atmosphere of Germany is one of frugality and industry, for all ages and for both sexes. The women work hard, and in the peasant class they do work of which the American woman knows nothing, such as plowing, sowing and harvesting on the farms. At the same time everyone is thrifty and honest. They all work for the love of working.

The idea of industry begins early, for one can see the little chaps going to school at 6:30 in the morning with knapsacks strapped to their backs soldier fashion, marching along without any fooling or loitering on the way, and then marching home in the same manner. They are real little soldiers. At the same time their manners are as gentlemanly and pleasing as one cares to see. Their schooling is very severe. They are educated along the lines of most rigid discipline, and no task is ever left unfinished or misunderstood.

Before I left Germany for home, I secured a young draftsman for the concern I was leaving, a man probably about 22 years of age. At first I was suspicious that he was not equal to the work, but I soon formed a different opinion. I found that I could learn from him in many ways. It was remarkable the amount of intelligence he displayed in making his drawings. When he had finished a drawing, it was done; no apologies nor additional instructions were necessary. Every screw and every hole were located and figured for strength. Every cam was completely developed and the keyways properly located with reference to the outline. Shafts were laid out with cranks, eccentrics, cams and collars, all located thereon, and located with such exactitude that a shaft made from the drawings with all the parts attached would enter the machine and function properly. These may be small points, details perhaps, but they showed a careful consideration of everything, and these elements ramify throughout the entire business structure.

Commercial Adaptability

In the general offices it is nothing to find stenographers who can write letters in five or six different languages with equal facility. The shipping departments know how to box and prepare shipments for export, with the knowledge that they will reach their destination uninjured. The finishing department knows that a machine or article intended for China should not be decorated with a Turkish coat-of-arms, nor provided with a catalog in English. Everything is considered from the viewpoint of the atmosphere of the country in which it is to be used, not only the big things, but the little things. They realize that life is too short to force strange products upon a foreign people, and wisely take the other course of adapting their products to the territory where they are to be sold.

Among the machinists, I found very little discontent; although none of the first-class men who worked for me received over 18 marks per week, about $4.50.

Social Conditions

One Sunday I met a man on the street who bowed and saluted me. He was

dressed in excellent taste in a frock coat and silk hat. For the life of me I could not place him, but returned his salutation, passed on, and forgot the incident. The next day one of my machinists said to me: "I guess you did not know me yesterday, did you?"

An American machinist earning $30 a week cannot afford to wear such clothes as did this man, and he was not an exception.

One of my German foremen invited me to dinner one Sunday, and I had the privilege of learning an important lesson. This man had a wife and six children; he worked in the machine shop every day, and spent his evenings at the trade school. Before he was married he had made with his own hands all the furniture required for his home, including the baby's crib. At dinner we sat down to a clean bare table before a large bowl of potatoes, a second bowl of chopped pig's feet and a bottle of beer. There was no butter, no pepper, no salt, no sugar. Potatoes are something that I seldom eat, but I ate them that day and enjoyed them. The chopped pigs feet was a luxury served because company was present. Such living is, of course, far below the American standard, yet as splendid specimens of manhood, womanhood and childhood are among these happy workers as I have ever seen in any part of the world.

As I was leaving for America I offered jobs to two men, guaranteeing them their passage to America and $20 per week wages. They refused to come, giving, as a reason, that they could make more in Germany, because of the less cost of living.

I was born and raised an American, and all of my people for 100 years back have been Americans, yet I cannot let my patriotism blind me to the fact that we can learn a great deal from Germany. The American standard of living is no standard at all. It is merely riotous extravagance.

Our American Government is spending huge sums and putting forth tremendous efforts to make our farmers rich. Experimental farms are established everywhere. Farm experts are sent out to teach improved methods of farming. Means are placed at the farmer's disposal whereby he can secure the best of education for his sons and daughters. Paralleling this, why not have educational facilities in our great export centers, facilities for the dissemination of knowledge which is necessary in order that our inland manufacturers may become acquainted with the factors that insure success in foreign trade?

The AMERICAN MACHINIST should expand this subject and by so doing will render our manufacturers a real service. Our export trade must be developed. Germany today can make tools, and many other things that we know nothing about better than we can, ship them to us and sell them for less than their equivalent can be produced in our own factories.

A Christmas Present

An announcement from the Baush Machine Tool Company states that, at the request of their president, F. H. Page, the board of directors voted to distribute a certain sum of money among their employees, as a kind of profit-sharing arrangement.

The amount so distributed this year aggregates 5 per cent. of the estimated profits for the year. In the future the amount given each employee will be determined by two factors, long and faithful service and intelligent service.

We congratulate both the Baush Machine Tool Company and their employees.

Brazing brass is a variety containing as small a quantity of zinc as possible and yet have the yellow color. According to the *Brass World* the object is to render it of a much higher melting point than that of the brazing solder. Brazed brass tubing is, for example, made of about 72 per cent. of copper and 28 per cent. zinc, while the solder used for brazing it contains equal parts of copper and zinc.

Increasing Shop Capacities

METAL WORKING

News items for the sales department—where more equipment will be needed. Authentic news is solicited for this department, not rumors or gossip—facts.

NEW ENGLAND

Plant of the Bacon & Donovan Engine Company, Springfield, Mass., was burned.

Marshall I. Smith, of Bristol, Conn., is arranging to move his machine shop to Hartford.

The National Spring Bed Company, New Britain, Conn., will erect a new five-story factory.

The Milford Auto Station, Milford, Mass., is in the market for a drilling and milling machine.

The Imperial Laundry Machinery Company, South Boston, Mass., is considering the removal of its plant.

The town of Northampton, Mass., intends to equip Smith Agricultural School with lathes, planers, band saws, etc.

The W. & R. Manufacturing Company, Attleboro, Mass., has been incorporated for $40,000 for manufacturing and dealing in jewelry.

The Lounsbury & Riley Machine Works, 3 Wall street, New Haven, Conn., has purchased property at 27 Artigan street, which will be remodeled to suit its purpose.

The Providence (R. I.) Blower Company has been incorporated with $200,000 capital to manufacture and sell blowers, machinery, etc. Incorporators, Martin A. O'Connor, John A. Doherty, John E. Canning.

MIDDLE STATES

The Auto Car Company, Ardmore, Penn., will erect a two-story addition.

The Buffalo (N. Y.) Boiler Works will establish a branch plant at Erie, Penn.

The West Shore Railroad Company will build a coach-repair shop at Weehawken, N. J.

The Ohio Electric Car Company, Toledo, Ohio, has increased its capital stock and is looking for site for a new plant.

The Reliance Engine and Iron Company, of Racine, Wis., will move its plant to La Crosse, Wis.

The Hawley Down Draft Furnace Company, Chicago, Ill., is considering the removal of its plant.

The Yoe Voting Machine Company, Dayton, Ohio, recently incorporated, is preparing to erect a plant.

Charles A. Fritz will erect a large garage and repair shop at 17 North Sixth street, Zanesville, Ohio.

The Dominion Stamping Company, of Walkerville, Ont., will build a branch plant at Detroit, Mich.

The Northern Machinery Company will build a plant to cost $7500 at Thirtieth street and North avenue, Milwaukee, Wis.

The Atlas Manufacturing Company, Big Rapids, Mich., making gasolene engines, rollers, etc., is planning the removal of its plant.

The Port Chester (N. Y.) Machine Works has been incorporated by George Fred and William Steinmetz to conduct a general machine shop.

The Navy Department, Bureau of Supplies and Accounts, Washington, D. C., will open bids January 3, for two drilling machines as per Schedule No. 3190.

Dayton Keyless Mail Box Company, Dayton, Ohio, has been organized to manufacture a patented mail box by William H. Gross, Daniel J. Glaser, Frank West, etc.

The James L. Taylor Manufacturing Company, of Bloomfield, N. J., making hardware specialties, will move to Poughkeepsie, N. Y., where a new plant is being erected.

The Igou Manufacturing Company, Springfield, Ohio, has been incorporated to manufacture machinery. Capital $100,000. Incorporators, Dennis T. Igou, P. A. Staley, D. C. Igou, etc.

John T. Walsh, of Pittsburg, Penn., is in communication with the Merchants Exchange, of Memphis, Tenn., regarding the establishment of a plant for the manufacture of automobile trucks.

The plant of the Brightman Manufacturing Company, of Shelby, Ohio, was destroyed by fire, entailing a loss of $150,000. The company manufactured shafting machinery and bolts and nuts.

The Marion Motor Company, Edgewater, N. J., has been incorporated to manufacture automobiles, motor vehicles, etc. Capital, $100,000. Incorporators, E. J. Forhan, G. F. Martin, H. P. Jones.

Sterling Pneumatic Cleaner Company, Cleveland, Ohio, has been incorporated with $10,000 capital to manufacture pneumatic cleaners. W. Allis, D. B. Wibist, J. F. Kingsley, etc., incorporators.

The Reliance Wrench Company, Racine, Wis., has been incorporated by Andrew Watson, W. H. Hartig, J. J. Christopher and Nels Christensen, to manufacture a patent wrench. Capital, $25,000.

Chicago Taxi Company, Chicago, Ill., has been incorporated to do a general automobile and garage business. Capital, $50,000. Incorporators, Wm. J. Candlish, Arthur B. McCold, Franklin Benjamin.

The Shannon Manufacturing Company, New York, has been incorporated to manufacture laundry machinery, etc. Capital, $300,000. Incorporators, J. H. Smith, New York; O. M. Shannon, New Rochelle, etc.

The Wilson Avenue Garage Company, Chicago, Ill., has been incorporated to do a general automobile and garage business. Capital, $10,000. Incorporators, E. A. Roser, Roy C. MacPherson, Edward J. Best.

The Cooper Hewitt Electric Company, Hoboken, N. J., has been incorporated to manufacture electrical goods. Capital, $2,500,000. Incorporators, Geo. Whitefield Betts, Jr., William Hazen Peck and Reese D. Alsop.

The Columbus Machine Company, of Columbus, Ohio, is looking for a new location and the Business Men's Organization, of Lancaster, Ohio, has made an offer for the foundry. One of the company's specialties is gas engines.

The A. M. Taylor Machine Company, Penn Yann, N. Y., has been incorporated to manufacture machinery for making grape baskets. Capital, $25,000. Incorporators, A. M. Taylor, K. Park, E. F. Lewis, A. N. Jameson, Rochester.

Barber Brothers, Syracuse, N. Y., have incorporated for the purpose of manufacturing and dealing in machinery, tools, hardware, etc. Capital, $50,000. Incorporators, Chas. E. Barber, Thos. J. Barber, Clarence C. Barber.

The Ragan, Brown & Lange Company, Napoleon, Ohio, has been incorporated to manufacture and sell engines, motors, couplings and other machinery. Incorporators, James P. Ragan, Jacob F. Brown, Henry Lange, etc. Capital, $40,000.

The Grieve Grate Company, New York, has been organized for the purpose of manufacturing grates, stove supplies, etc. Capital, $100,000. Incorporators, C. E. Bedford, New York; W. C. Crosby, Essex Falls, N. J.; A. Lewis, Brooklyn.

The United Engineering and Foundry Company, of Pittsburg, Penn., has plans completed for a new plant, near Tarentum, in which will be manufactured electric rock drills, automobile wheels and machinery for rolling mills, etc.

The Whiting Motor Company, East Orange, N. J., has been organized with $12,000 capital to manufacture motors, buggies, wagons, etc., and do a general machinery repair business. Incorporators, Harry H. Picking, Chas. O. Geyer, Frank E. Ruggles.

Joseph H. Jackson, formerly with the Yost Typewriter Manufacturing Company, of Buffalo, N. Y., has invented the Calypso electric typewriter and is interested in the organization of a company to establish a plant for the manufacture of same.

The E. A. Fay Company, Cincinnati, Ohio, has been organized with a capital of $75,000 to manufacture and sell lightning rods and electrical equipment. Incorporators, E. A. Fay, Mary A. Fay, William F. Fay, Robert E. Hutchins and C. I. Burdge.

Fire partially destroyed the Mundy factory building, at 22 Prospect street, Newark, N. J., damaging the machine shop of J. S. Mundy, and factories of Lebkuecher & Co., silversmiths, and A. F. Meiselbach & Bros., making fishing reels, hooks, etc.

The Ozone Company, Cleveland, Ohio, has been incorporated with a capital of $10,000 to manufacture all kinds of electrical apparatus and to do a general manufacturing business. P. D. Metzgar, R. D. Williamson, P. C. Stoller, etc., incorporators.

Central Metal Bed Company, New York, incorporated with a capital of $12,000 to manufacture brass and iron beds, etc. Incorporators, Barnet Shapiro, 127 Newton street, Brooklyn, N. Y.; I. H. Bendler, 224 East Eleventh street, New York, etc.

The H. Straus Machine Company, New York, has been incorporated to manufacture motors, engines, etc. Capital, $20,000. Incorporators, Hans Straus, New Rochelle, N. Y. Wm. F. Wagner, 101 West Seventy-eighth street; David B. Cahn, 116 East Sixty-first street, New York.

SOUTHERN STATES

The plant of the Elizabeth City (N. C.) Iron Works Company was destroyed by fire. Loss, $20,000.

The Queen & Crescent Railroad contemplate improvements at its shops in Oakdale, Tenn., including considerable new shop machinery.

WEST OF THE MISSISSIPPI

P. J. Storms, Seeley, Cal., is building a blacksmith shop.

George Miller, of Menlo, Iowa, will build a blacksmith shop at once.

The Waterloo (Iowa) Gas Engine Company is building additions to its plant.

The Hofius Steel Company, Seattle, Wash., will build an addition to its shop.

Fire destroyed the foundry of the Interstate Car Company, at Brightwood, Ind.

The Temple Lumber Company, Pineland, Tex., is installing a large machine shop.

The Hastings (Mich.) Foundry and Iron Works will erect four additional buildings.

The Hassell Iron Works Company, Colorado Springs, Colo., is rebuilding its burned plant.

The Smith Automobile Company, Topeka, Kan., is considering the removal of its plant.

Stanley Kapalinski, of Morton, N. D., will erect a blacksmith and wagon shop at Holdinford, Minn.

The Railway Equipment Company, Portland, Ore., has completed its new shops at Willbridge, Ore.

Emil Koenig, Ontario, Cal., will build a foundry at Upland, Cal. Modern equipment will be installed.

W. H. Sorrill, Spokane, Wash., will build a garage and repair shop. Modern equipment will be installed.

The Hastings (Neb.) Foundry and Iron Works has commenced the construction of five new buildings.

The Minneapolis (Minn.) Threshing Machine Company is planning the erection of a plant at Mason City, Iowa.

N. C. Simonson, inventor of a trimming shear, will have a factory built at Sioux Rapids, Iowa, to manufacture same.

W. R. Rust will erect a commercial garage on North Sixth street, Tacoma, Wash. Modern repair equipment will be installed.

Edgar Baruch, Los Angeles, Cal., will build a commercial garage and repair shop on Grand avenue. Modern equipment will be installed.

Plans have been completed for the new factory of the Schurmeier Motor Car Company, at University avenue and Griggs streets, St. Paul, Minn.

The Thornhill Automobile Agency, Wenatchee, Wash., will build a commercial garage and repair shop. Modern repair equipment will be installed.

The Northern Electric Company, Sacramento, Cal., has purchased property in West Sacramento, and will build shops, switching yards, etc., on the site.

Chicopee Motor Car Company, St. Louis, Mo., has been organized to manufacture and deal in automobiles, by Harry C. Carr, Francis V. Carr, Jackson J. Blincoe.

The Foederer Foundry Company, Indianapolis, Ind., has been incorporated with $10,000 capital. Directors are A. Foederer, L. S. Foederer, Geo. S. Foederer.

Fire at the factory of the Twin City Separator Company, Minneapolis, Minn., caused a loss of several thousand dollars. The company manufactures fanning mills and grain-cleaning machinery.

The Springer-Whitaker Foundry Company, Terre Haute, Ind., has been incorporated to do a general foundry business. Capital, $10,000. Incorporators, A. H. Springer, A. C. Whitaker, M. A. Whitaker.

The Foss Valve and Brass Manufacturing Company, St. Louis, Mo., has been incorporated to manufacture and deal in brassware. Capital, $50,000. Incorporators, Clarence E. Englin, Wm. J. Gates, G. Howard Willett, etc.

The Railway Specialty Company, of Atchison, Kan., has increased its capital from $50,000 to $1,000,000 and will build a large plant. The company manufactures gasolene engines and gasolene trucks for the use of railroad section men.

CANADA

The Owl Metal Company will locate a plant at Winnipeg.

Warren Brothers, of St. Catherines, will extend their machine shops.

The Ottawa Vacuum Cleaner Company will locate a factory at Ottawa.

The Lachine Bridge Company, of Lachine, Quebec, will extend its plant.

The Hamilton Tube Company, of Hamilton, Ont., will extend its factory.

The Grand Trunk Pacific Railway will build large shops at Regina, Sask.

The C. P. R. will build a large new roundhouse and shops at Coquitlam, B. C.

W. McLean, of Bryson, Quebec, will locate a machine shop and foundry at Renfrew, Ont.

The Western Bridge and Equipment Company will locate a factory at Chatham, Ont.

The Booth Coulter Brass Company, is building a large new foundry at its Toronto factory.

The United Shoe Machinery Company, of Maisonneuve, Quebec, is building a large new factory.

L. A. David, of Montreal, is head of the Canadian Monorail Car Corporation, which will have a large plant there.

Samuel Wood, of Toronto, is head of the Canadian Electric Fixture and Contracting Company, which will locate there.

The machine shops of Connells Foundry, at Woodstock, N. B., wiped out by fire, will be reequipped at once. Loss, $25,000.

T. E. Reeb, of Welland, Ont., states that his large machine shops, recently completely destroyed by fire, will be reequipped at once.

James A. Moore, of Irondale, Wash., is president of the Western Steel Corporation, which will spend $2,000,000 on a mammoth steel plant at Vancouver.

General Manufacturing

NEW ENGLAND

The Atlantic Mills, Providence, R. I., are improving their power plant.

H. A. Carter, Melrose, Mass., is in the market for a small gasolene engine.

J. A. Nason, West Boxford, Mass., is in the market for a single-surface planer.

Fire destroyed the woodworking plant of Jones & Shields, St. Johnsbury, Vt.

An extensive addition is being built at the Interlaken Mill, at Arkwright, R. I.

New machinery will be installed in the electric-light plant at Wakefield, Mass.

Hall Brothers, Norwich, Conn., will install new machinery in their weaving plant.

The broom factory of F. Strauss, Providence, R. I., was badly damaged by fire.

The Whittenton Manufacturing Company, Taunton, Mass., will install 200 new looms.

The Namquitt Worsted Mills, Bristol, R. I., will make additions to its plant and equipment.

The Glen Worsted Company has been organized and will locate a plant at Killingly, Conn.

Fire destroyed the plant of the Victor Sporting Goods, Springfield, Mass. Loss, $30,000.

Fire destroyed the factory of the Chester (Vt.) Bobbin, Spool and Shuttle Company. Loss, $10,000.

A powder-house explosion badly damaged the Farnum-Cheshire Lime Company's plant at Cheshire, Mass.

The E. A. McMillin Company, North Adams, Mass., is to erect a two-story addition to its paper-box factory.

The plant of the C. A. Nichols Publishing Company, Springeld, Mass., was destroyed by fire. Loss, $10,000.

The Vera Chemical Company, Stoneham, Mass., is erecting a new dry size house and expect to erect two more.

The B. & R. Rubber Company, North Brookfield, Mass., contemplates expending $40,000 for new equipment.

The W. W. Windle Wool Scouring Company, Millbury, Mass., contemplates installing an electric motor in its plant.

The plant of the Pawtucket (R. I.) Electric Company is being doubled, including the capacity of the power house.

The Draper Brothers Company, Canton, Mass., is building a new woolen mill to accommodate increasing business.

The plant of the Bay State Leather Manufacturing Company, Salem, Mass., was destroyed by fire. Loss, $100,000.

The Beebe & Richards Rubber Company, North Brookfield, Mass., will make improvements and buy new machinery.

The Fort Dummer Mills has been organized at Brattleboro, Vt., with a capital of $450,000 to manufacture fine and fancy cotton goods. Plans are being made for a building.

Mason C. Miller, of Hartford, Conn., owner of the Eastern Paper Box Company, whose plant in Hartford recently burned, has purchased property on North Main street, Manchester, Conn., and will locate a plant there.

MIDDLE STATES

The Zanesville (Ohio) Broom Company

The Buckeye Aluminum Company, Wooster, Ohio, will build a new plant.
will build a new plant.

Portsmouth, Ohio, will build a new waterworks plant to cost $100,000.

The Clayville (N. Y.) Knitting Company is planning to enlarge its plant.

The Crystal Ice Company, Marietta, Ohio, will enlarge its cold-storage plant.

The Phœnix Knitting Works, Milwaukee, Wis., will erect a five-story addition.

The Sandoval (Ill.) Zinc Company is contemplating installing an electric-light plant.

The Du Pont Powder Company, Wilmington, Del., will double the size of its power plant.

The American Agricultural Chemical Company, Detroit, Mich., will erect a two-story factory.

Fire destroyed the factory of the John Morrison Brush Company, Troy, N. Y. Loss, $25,000.

F. P. Beaver, Dayton, Ohio, is having plans made for a power plant to cost $100,000.

The Gaylord (Mich.) Motor Company is preparing to manufacture its own automobile bodies.

Fire did $15,000 damage at the plant of the Chadakoin Furniture Company, Jamestown, N. Y.

The Wyoming Paper Mills, Pittston, Penn., has not changed hands as noted in the December 8 issue.

The Cunningham Piano Company, Philadelphia, Penn., has purchased site for an addition to its plant.

The Lyon Metallic Manufacturing Company, Aurora, Ill., will put in a new generating plant in the spring.

The Adler Ice Cream Company, of Milwaukee, Wis., will erect a factory at East North avenue and Cambridge.

Jos. W. Bancroft & Sons, Wilmington, Del., textile mills, will shortly make extensive additions to their power equipment.

E. P. Reed & Co., shoe manufacturers, Rochester, N. Y., propose to locate a branch factory probably at Ogdensburg.

The Hall Printing Press Company, Dunellen, N. J., intends to install individual motors to operate its heavier machine tools.

The Woodsell Tanning Company, now at Oraton and Verona avenues, Newark, N. J., is seeking site in New England on which to locate.

The St. Louis & Illinois Coal Company, Edwardsville, Ill., is contemplating the installation of an electric plant for haulage and cutting.

The New York State School for the Blind, Batavia, N. Y., will build a refrigerating plant as per plans of Franklin B. Ware, State architect, Albany, N. Y.

The American Concrete Company, 184 La Salle street, Chicago, Ill., is looking for site on which to erect a new plant for the manufacture of heavy concrete piling, blocks, etc.

The plant of the Ely Manufacturing Company, at Girard, Penn., was destroyed by fire, causing a loss of about $50,000. The company manufactured wood specialties, rat traps, etc.

F. L. Bader, architect, of Milwaukee, Wis., is preparing plans for a 1,000,000-bushel malting plant at Twenty-third avenue and Burnham street, Milwaukee, for the Hansen Malting Company.

The National Cable and Manufacturing Company, Niles, Mich., has purchased the factory of the Eager Manufacturing Company, and will use same for the extension of its business.

Explosion wrecked the plant of the Fredonia Heating Company and damaged the power house of the Buffalo, Lake Erie & Western Traction Company, at Fredonia, N. Y. Will be rebuilt.

The Freiday Paper Box Company, Newark, N. J., has been incorporated to manufacture paper, paper materials, etc. Capital, $50,000. Incorporators, Wm. S. Freiday, M. B. Freiday, Geo. W. Anderson.

The Wooster Shale Brick Company, Wooster, Ohio, has been organized to manufacture bricks and other clay products. Incorporators, W. R. Barnhart, Jr., Paul S. Barnhart, John H. Wilson, etc. Capital, $15,000.

The S. C. Regulator Manufacturing Company, Fostoria, Ohio, has been formed with $100,000 capital to manufacture and sell water-level regulators. Incorporators, N. Guy Copley, George A. Snyder, Francis D. Kingseed, etc.

The Navy Department, Bureau of Supplies and Accounts, Washington, D. C., will open bids January 3, for four ventilating sets (schedule 3202), 5300 pounds steel bolts and nuts, emery cloth, hinges, bronze locks (schedule 3197), 30,000 pounds medium angle steel, 7800 galvanized sheet steel, 148,600 pounds steel shapes (schedule 3200), 62,700 pounds nickel-steel forgings (schedule 3195); January 17—516 high-speed twist drills (schedule 3205), one motor headstock for 14-inch speed lathe, one 24-inch planer and jointer (schedule 3188).

SOUTHERN STATES

The plant of the Hagerstown (Md.) Woodenware Company was destroyed by fire.

The Anderson-Tulley Lumber Company, Memphis, Tenn., will install a Corliss engine.

The Porter Wadley Lumber plant, at Cotton Valley, La., was destroyed by fire. Loss, $60,000.

The sawmill of the Porter-Wadley Company, at Cotton Valley, La., was destroyed by fire. Loss, $60,000.

The Thornhill Wagon Company, Lynchburg, Va., whose plant recently burned, will rebuild on a larger scale.

The Wilkes Veneering Works Company, whose plant at South Norfolk, Va., recently burned, is looking for suitable site for a new plant.

The Chattanooga (Tenn.) Box and Lumber Company has been incorporated with $35,000 capital by Charles Reif, J. Walter Peak, Frank Carden and others.

Columbia Tile Company, Grafton, W. Va., has been incorporated to make tile, pottery, etc. Capital, $150,000. Incorporators, Chas. R. Durbin, J. W. Yates, A. Hood Phillips, etc.

The Sanitary Ice Company, Clarksburg, W. Va., has been incorporated to manufacture ice. Capital, $75,000. Incorporators, M. E. Henderson, John Patton, Nathan Knight, etc.

WEST OF THE MISSISSIPPI

N. Coleman, Leavenworth, Wash., will build a sawmill at Chelan, Wash.

P. J. McHugh's asphalt plant, at Seattle, Wash., was damaged by fire.

The Savery Cafe, at Des Moines, Iowa, will install a refrigerating plant.

Bonds were voted for a waterworks and electrical plant at Giltner, Neb.

Lindsey & Co., Great Falls, Mont., will erect a modern fruit warehouse.

The city of Ellinsburg, Wash., has issued $300,000 bonds for waterworks.

F. Q. Story, Alhambra, Cal., has taken out a permit to erect a packing house.

Lamar & Othmer, of Muscatine, Iowa, will build a new button factory at once.

The Weed Lumber Company, Weed, Cal., is making alterations in its blower system.

Leavenworth, Wash., will vote on the issuing of $45,000 bonds for waterworks.

Fire destroyed the plant of the C. Flick Box Company, Dubuque, Iowa. Loss, $30,000.

Summers Brothers, Sandpoint, Idaho, will move their match factory to Newport, Wash.

The Portola Water Company, Portola, Cal., will make improvements in its water system.

D. E. Edstrom, Seattle, Wash., is planning to establish a modern steam-laundry plant.

Sam Blank, of Valley City, N. D., will erect a two-story cold-storage plant in the spring.

The Standard Pottery Company, Los Angeles, Cal., is building an addition to its plant.

The town of North Mankato, Minn., will vote on a bond issue of $200,000 for waterworks.

A heating plant will be installed in the new building of the Woman's Club, Phœnix, Ariz.

The Lake Preston (S. D.) Bottling Works will build a two-story addition. Mr. Pieck, manager.

S. B. Reed, Seattle, Wash., has taken out a permit for the erection of a building for dye works.

J. C. Kelly, of Charles City, Iowa, is interested in establishing a canning factory at this place.

The city of Sawtelle (near Los Angeles), Cal., contemplates expending $75,000 in a new sewer system.

The city of Hanford, Cal., contemplates the installation of a municipal sewer system to cost $100,000.

Earl E. Miller, Twin Falls, Idaho, has been granted a franchise to construct gas works and gas system.

The Yucaipa Land and Water Company, Yucaipa, Cal., will make improvements in its water system.

The Valley Development Company, Chehalis, Wash., is having plans prepared for a new power plant.

The Hebron Brick Company, of Hebron, N. D., is considering the location of a branch plant at Mott, N. D.

Equipment will be required in the $200,000 apartment hotel to be erected at Long Beach, Cal., by J. M. Parsell.

The Citizens Heat and Light Company, Elwood, Ind., will build an artificial gas plant to cost $25,000.

The Desoto Creamery Company, of Minneapolis, Minn., will erect a creamery on Nicollet island, Minneapolis.

The Pioneer Truck Company, San Diego, Cal., will build a warehouse. Modern equipment will be installed.

The National Orange Company, Corona, Cal., will build a packing house. Modern equipment will be installed.

C. C. Chapman, Fullerton, Cal., will erect a packing house near this city. Modern equipment will be installed.

J. W. Rannells, Los Angeles, Cal., is contemplating the erection of a cotton gin on his property at Rannells, Cal.

The Michigan Furniture Company, State and Adams street, Tacoma, Wash., is contemplating enlarging its plant.

The Pike Electrical Manufacturing Company, of Minneapolis, Minn., is considering locating its plant at Anoka, Minn.

The British Columbia Portland Cement Company, Vancouver, B. C., will build a plant. Plans are being prepared.

J. F. Clarke, Pasadena, Cal., will build a warehouse building on Fair Oaks avenue. Modern equipment will be installed.

The Tucannon Valley Produce Company, of Pomeroy, Wash., is considering the erection of a cannery and cold-storage plant.

An electric passenger elevator will be installed in the new building to be erected at Los Angeles, Cal., by E. P. Bryan.

Steam-heating equipment will be installed in the new hotel building to be erected at Los Angeles, Cal., by William Garland.

The Los Angeles Railway Company, Los Angeles, Cal., is building a substation at Ardmore avenue and San Marino street.

The H. Steen Mill Company, Vashon, Wash., is building a complete new lumber-mill plant, including a planing mill and box factory.

The Union Lithograph Company, San Francisco, Cal., has purchased property and will erect a large plant at Los Angeles, Cal.

The Palo Verde Mutual Water Company, Blythe ranch, Cal., will make extensions in its water system, in the Palo Verde valley.

The Interstate Realty and Improvement Company, San Diego, Cal., is planning for extensive improvements in its water system.

The Los Angeles Gas and Electric Corporation, Los Angeles, Cal., is planning for the erection of additional buildings to its plant.

Equipment will be required for the new high-school building to be erected at Selma, Cal. F. S. Allen, architect, Los Angeles, Cal.

The Canadian Western Lumber Company, Fraser Mills, will erect a new lumber plant, including a sash and door factory and cedar mill.

At a special election the citizens of Coggon, Iowa, voted a special tax for the erection and maintenance of an electric-light plant.

Geo. D. Shearer, San Rafael, Cal., is planning to construct and operate an electric street-car system. A franchise has been granted.

A water and sewer system and lighting plant will be installed at the Fort Lapwai Indian School, at Lapwai, Idaho. John Charles, Denver, Colo., supervisor of construction.

The city of Brawley, Cal., will install a municipal water system to cost $30,000. Plans are now being prepared by the city engineer.

The city of Brawley, Cal., will install a municipal water system to cost $30,000. Plans are now being prepared by the city engineer.

The Indian Valley Light and Power Company, Greenville, Cal., is preparing plans for a large power plant. O. C. Pratt, general manager, Crocker building, San Francisco, Cal.

The Seven Grain Food Company has filed articles of incorporation at San Diego, Cal. The company plans to build a flour mill in this city.

The West Ontario Mutual Water Company, Ontario, Cal., has been incorporated and will make extensive irrigation improvements in this section.

The North Yakima Milling Company, operating a flour mill at North Yakima, Wash., is planning to install additional machinery in the near future.

The National Dry Products Company, Chicago, Ill., is looking for a site to establish a factory at Tacoma, Wash. The company manufactures powder.

The Corcoran Creamery, Corcoran, Cal., will double the capacity of its plant and will install machinery for the manufacture of a condensed-milk product.

The Idaho Consolidated Power Company, American Falls, Idaho, will increase the capacity of its plant from 3000 to 30,000 horsepower in the near future.

George Wingfield, Winnemucca, Nev., will build a large hydroelectric plant on the Humboldt river for operating a reduction plant at the Buckhorn mines.

The Salmon Falls Light and Power Company, Payette, Idaho, has filed articles of incorporation. The company has a site and will erect a hydroelectric plant.

The Portland Railway, Light and Power Company, Portland, Ore., has filed plans for a new substation in this city; $40,000 will be expended on generating equipment.

The plant of the Acme Mill Company, Portland, Ore., was damaged to the extent of $35,000 by fire; $25,000 worth of machinery was destroyed. Plant will be rebuilt.

The Bailey Lumber Company, New Westminster, B. C., has completed a new sawmill. A planing mill, lath mill and additional improvements are planned for the near future.

The Ladysmith Lumber Company has purchased the lumber mill of the Red Fir Lumber Company, at Nanaimo, B. C. The plant will be remodeled and new machinery installed.

The Monterey County Gas and Electric Company, Monterey, Cal. (F. G. Baum, San Francisco, Cal., owner), contemplates extensive improvements in the Salinas water system.

The Cardinal Cabinet Company has been incorporated at Wabash, Ind., to manufacture cabinets. Capital, $50,000. Incorporators, J. A. Osborn, J. H. Stegleman, E. L. Weisner, etc.

Steam-heating equipment and vacuum-cleaning apparatus will be required in the apartment house to be erected at San Francisco, Cal., by Christine Blake. J. F. Dunn, architect, San Francisco.

Power-plant equipment, ventilating apparatus, etc., will be required in the Children's Hospital to be erected at Los Angeles, Cal. About $75,000 will be expended. Hunt, Eager & Burns, architects, Los Angeles, are now working on plans.

The Green River Hot Springs Company, North Yakima, Wash., is having plans made for a $50,000 hotel building. Equipment will be required. The company will also build a power house and additional buildings, plans to be drawn later.

The Washington Portland Cement Company, Concrete, Wash., will increase the capacity of its plant. New buildings will be erected; equipment for manufacturing will be required. The power plant will be enlarged; $30,000 will be expended.

CANADA

Listowel, Ont., will install an electric-light plant.

Ridgetown, Ont., will install a new waterworks plant.

Oak Bay, B. C., will install a new waterworks system.

The Toronto Type Foundry is building a branch at Regina.

The Western Paint Company, of Winnipeg, is extending its plant.

Brandon, Manitoba, will spend $50,000 extending its water system.

Ottawa, Ont., is in the market for a complete rock-crushing outfit.

Victoria, B. C., will spend $25,000 for new electrical equipment.

Burnaby, B. C., will install a complete waterworks pumping plant.

Fort William, Ont., will spend $65,000 for new waterworks equipment.

The Light, Heat and Power Company, of Kingston, Ont., will extend its plant.

Fire destroyed the compressor house at No. 1 colliery, Sidney mines, Halifax, N. S.

Strathroy, Ont., will greatly improve its electric-lighting and waterworks systems.

Berlin, Ont., will spend $50,000 for new electric-lighting machinery and equipment.

The Diamond Flint Glass Company will build a large new factory at Hamilton, Ont.

The Canadian Keg and Barrel Company will build a large new factory at Orillia, Ont.

The Canadian Heating and Ventilating Company, of Owen Sound, will double its plant.

The Robinson Box Company, of Lowell, Mass., will locate a branch factory at Hamilton, Ont.

The Independent Rubber Company will spend $500,000 equipping a large factory at Merritton, Ont.

The large new hydroelectric shops of the Niagara Power Commission will be located at London, Ont.

The large plant of the Dominion Cooperage Company, wiped out by fire, at Brigden, Ont., will be reequipped.

The Dorchester Electric Company is building a $200,000 plant at Quebec to supply the city with electricity.

The Canadian Explosives Company, capitalized at $15,000,000, will locate a large new factory in Montreal.

C. Hoffman is manager of a company which will install a $100,000 plant at Lethbridge, Alberta, for making ice.

Calgary, Alberta, is in the market for a 1500-horsepower synchronous motor generator and one motor-generator exciter set.

James Robinson, of Millerton, N. B., is head of a company, which will equip a large new paper mill at Grand Falls, N. B.

The Canadian Fishing Company, of Vancouver, B. C., will spend $150,000 for machinery for a modern cold-storage plant.

MINING

The Colorado mines, Chihuahua, Mexico, will install a 200-ton cyanide plant.

The Van Roi mine, British Columbia, is building a new concentrating plant.

The Pavlak Company, operating in the Jarbidge district, Nev., will install a cyanide plant.

The Tuolumne mine, near Butte, Mont., will make extensive improvements in its equipment.

The Morning Star mine, Nevada county, Cal., will build a 10-stamp mill in the near future.

The Steptoe Valley Smelter, near Ely, Nev., is making improvements and additions in its property.

The Berkeley mine (formerly Ida Klein), in Tuolumne county, Cal., will install new equipment.

The Red Top Extension property, near Goldfield, Nev., will install a new hoist and air compressor.

A 20-stamp mill will be erected at Mother Lode, Sheep Creek, British Columbia, by the Eureka mine.

The Mines Company of America will install a new mill at its La Dura mine, Sonora county, Mexico.

The Diamond mines, near Yreka, Cal., are planning to install a reduction plant in the summer of 1911.

The C.O.D. Consolidated Mining Company, Goldfield, Nev., is contemplating the erection of a large mill.

The Republic Mines Corporation, Republic, Wash., will install a new mill at its Lone Star-Surprise mine.

Mizpah Extension mine, in Nye county, Nev., will install a compressor for air drills in the near future.

The Sinaloa Reduction Company, operating in the vicinity of Guliacan, Mexico, will install a cyanide plant.

The Granby Mining and Smelting Company, Prince Rupert, B. C., contemplates the erection of a smelter.

J. H. Ehlers, Spokane, Wash., is making arrangements to install a saw mill at his Sylvanite mine, Troy, Mont.

The Butte Reduction Works, Butte, Mont., will add new equipment to its concentrator for the treatment of zinc ore.

The Homestake mines, Salmon River district, Siskiyou county, Cal., will install new machinery and make extensive improvements.

The concentrating plant of the Arizona Copper Company, at Clifton, Ariz., will be increased from 800 to 1500 tons daily capacity.

The Centerville Mine and Milling Company, operating on Grimes Creek, Boise county, Idaho, will rebuild its plant recently destroyed by fire.

The Ruby mines, in Copper Basin, Yavapai county, Ariz., owned by the Yavapai Bullion Company, is contemplating extensive improvements in its plant.

The Union Gold Mining and Milling Company, operating in the White Tank mountains, near Phœnix, Ariz., contemplates the erection of a stamp mill.

The Mortimer Mining Company, Philadelphia, Penn., operating in Inyo county, Cal., near Lone Pine, is contemplating the erection of a 20-stamp mill.

The stamp mill of the White Gold Mining Company, near Wickenburg, Ariz., was destroyed. The mill will be immediately replaced with a larger capacity.

The Klondike Mining and Milling Company, operating in Siskiyou county, Cal., must install a cyanide plant according to a court decision in a suit brought by a stockholder.

CATALOGS WANTED

Anton Traut, Museum Strasse, Innsbruck, Austria, wishes to establish an agency for American woodworking and other machinery, and would be glad to receive catalogs, prices, etc.

TRADE CATALOGS

The Adams Company, Dubuque, Iowa. Circular No. 821. Farwell gear tester. Illustrated.

Chicago Pneumatic Tool Company, Chicago, Ill. Catalog No. 33. Franklin air compressors. Illustrated, 96 pages, 6x9 inches, paper.

The Bristol Company, Waterbury, Conn. Bulletin No. 140. Recording gages for pressure and vacuum. Illustrated, 48 pages, 8x10½ inches.

The Osborn Manufacturing Company, Cleveland, Ohio. Catalog No. 131. Foundry supplies, molding machines, hardware specialties. Illustrated, 6x9 inches, 240 pages, paper.

FORTHCOMING MEETINGS

Society of Automobile Engineers, annual meeting, January 11 and 12, New York City; C. F. Clarkson, secretary, 1451 Broadway, New York City.

The National Civic Federation, eleventh annual meeting, January 12-14, New York City; D. L. Cease, secretary, 1 Madison avenue, New York City.

National Metal Trades Association, annual meeting, April 14, 1911, New York City, Hotel Astor. Robert Wust, commissioner, New England building, Cleveland, Ohio.

American Foundrymen's Association, annual convention, Pittsburg, Penn., May 23 to 26, 1911. Richard Moldenke, secretary, Watchung, N. J.

American Society of Mechanical Engineers; monthly meeting second Tuesday. Calvin W. Rice, secretary, 29 West Thirty-ninth street, New York City.

Boston Branch National Metal Trades Association. Monthly meeting on first Wednesday of each month, Young's hotel. D. F. S. Clark, secretary, 141 Milk street, Boston, Mass.

Providence Association of Mechanical Engineers. Monthly meeting fourth Tuesday each month. E. C. Bliss, president, 91 Sabine street, Providence, R. I.

New England Foundrymen's Association; regular meeting second Wednesday of each month, Exchange Club, Boston, Mass. Fred F. Stockwell, 205 Broadway, Cambridgeport, Mass.

Engineers' Society of Western Pennsylvania; monthly meeting third Tuesday. Elmer K. Hiles, secretary, Fulton building, Pittsburg, Penn.

Superintendents' and Foremen's Club of Cleveland; monthly meeting third Saturday. Philip Frankel, secretary, 310 New England building, Cleveland, O.

Western Society of Engineers, Chicago, Ill. Regular meeting first Wednesday evening of each month, excepting July and August. Secretary, J. H. Warder, 1735 Monadnock block, Chicago, Ill.

Philadelphia Foundrymen's Association; meetings first Wednesday of each month, Manufacturers Club, Philadelphia, Penn. Howard Evans, secretary, Pier 45 North, Philadelphia, Penn.

WANTS

Rate 25 cents per line for each insertion. About six words make a line. No advertisements abbreviated. Copy should be sent to reach us not later than Friday for ensuing week's issue. Answers addressed to our care, 505 Pearl Street, New York, will be forwarded. Applicants may specify names to which their replies are not to be forwarded, but replies will not be returned. If not forwarded, they will be destroyed without notice. No information given by us regarding any advertiser using box number. Original letters of recommendations or other papers of value should not be inclosed to unknown correspondents. Only bona-fide advertisements inserted under this heading. No advertising accepted from any agency, association or individual charging a fee for "registration," or a commission on wages of successful applicants for situations.

MISCELLANEOUS WANTS

Caliper catalog free. E.G.Smith, Columbia, Pa.

We buy or pay royalty for good patented machine or tool. Box 282, AMER. MACHINIST.

Wanted—Work for screw machines and gear cutter. Box 775, AMERICAN MACHINIST.

Light, fine machinery to order; models and electrical work specialty. E. O. Chase, Newark, N. J.

Engineering work and drawings made, patents developed; reasonable prices. Box 300, AMERICAN MACHINIST.

Special machinery designed; drafting, tests, reports. Reliance Eng. Co., 113 Beekman street, New York City.

Wanted—Good lines for Pacific coast by experienced and well known machinery salesman. Box 286, AMERICAN MACHINIST.

Light and medium weight machinery and duplicate parts built to order; tools, jigs, etc. MacCordy Mfg. Co., Amsterdam, N. Y.

Patents. C. L. Parker, Patent Attorney, ex-examiner Patent Office, 900 G St., Washington, D. C. Write for Inventor's Handbook.

Wanted—Well equipped machine shop wants specialty or article of general manufacture to make and sell under royalty arrangement, or will buy outright. Box 219, AMER. MACH.

Large English firm of machine tool importers having showrooms and offices in Great Britain, France, Germany, Italy, India and Japan is wanting good agencies for machine tools of all kinds. Box 189, AMER. MACH.

Modern fire arms factory with very extensive and complete machinery equipment and an A-1 organization would like to take on the manufacture of profitable line in connection with regular product. Box 301, AM. MACH.

Manufacturer of telegraph machines, adding machines, taxameters, accurate interchangeable parts, dies and special tools, invites orders for similar special manufacturing. The Universal Telegraphic Company, Successors to the Rowland Telegraphic Company, Baltimore, Md.

HELP WANTED

Classification indicates present address of advertiser, nothing else.

ILLINOIS

Wanted—A designer: the advertiser, one of the largest automobile concerns in the country, not located in Michigan, has an opening for an experienced and practical designer who has made good in the past; the applicant must have a knowledge of foreign and domestic practice; state age, experience and salary expected; a good opportunity for a first class man. Box 282, AMER. MACH.

Opportunity—Superintendent or foreman, assembly room Chicago factory, good pay to start, great future for common-sense hustler, not over forty years; must be worker, able to handle men and women, show them how to work, get out big quantities at low cost made right; prefer young man employed in similar capacity in big concern; do not expect to know our line; will teach right man; give full particulars first letter. Box 295, AMERICAN MACHINIST.

INDIANA

Superintendent of mechanical specialty factory, $150-$200; practical mechanical foreman for machine shop employing 15-30 men, $120-$140; give experience in full. Box 306, AMERICAN MACHINIST.

Wanted—Motor designer and factory engineer; good opening with large concern for experienced man; must be thoroughly competent and have previous experience designing and building successful motors; state age, previous positions, etc., in first letter; if satisfactory, will arrange personal interview. Address "Motor Designer," AMER. MACHINIST.

MASSACHUSETTS

Head draftsman and designer, experienced on rotary printing presses and folders. Box 132, AMERICAN MACHINIST.

MICHIGAN

Wanted—Experienced assemblers and mounters for machine tool work; steady work and good wages to the right men; ideal shop conditions. Grant & Wood Mfg. Co., Chelsea, Mich.

MINNESOTA

Wanted—An experienced, high grade machine shop superintendent, one that can handle men and get the best possible results out of the equipment, in a plant situated in the Middle West; will pay good salary to man that can make good. Address stating age, references, etc., Box 296, AMER. MACH.

MISSOURI

Wanted—Inspector on machine work in large manufacturing company in the West. Box 303, AMERICAN MACHINIST.

NEW JERSEY

Wanted—First class printing press designers, draftsmen and detailers; good position for men of ability. Hall Printing Press Company, Dunellen, N. J.

Wanted—Young man desiring to learn business and manufacturing who can invest $25,000 in a first class, well established, paying trade located near New York City; technical graduate preferred; must be a worker, habits irreproachable; above representing half interest, larger interest will be sold later. Box 309, AMERICAN MACHINIST.

Wanted—A first class printing press mechanic, to fill position of inspector and foreman of assembling floor; must be a trained mechanic with experience in determining accuracy at work, and its requirements in fitting and operation; a man of judgment who will assume responsibility. Hall Printing Press Company, Dunellen, N. J.

NEW YORK

Gridley operators wanted; several good men on Gridley automatic machines. F.I.A.T., Poughkeepsie, N. Y.

Wanted—Experienced draftsmen for steam piping, structural steel and furnace work in small town, New York State. Box 308, AM. M.

Wanted—Machine shop foreman on iron valve work; good wages, plenty of work; must be experienced on this line. Box 311, AMERICAN MACHINIST.

Wanted—First class lathe hands for gear blank work; steady employment; state age, experience and wages desired. Box 283, AMERICAN MACHINIST.

Milling machine hands wanted; first-class men for Cincinnati plain and universal machines; steady employment, good wages. F.I.A.T., Poughkeepsie, N. Y.

Experienced skilled die maker and machinist wanted; permanent position and good salary if you produce and make good. Address "Manufacturer," AMERICAN MACHINIST.

A thoroughly competent foreman to take charge of an automobile repair business; must be a thoroughly good automobile adjuster. Youngs & Co., Newburgh, N. Y.

Wanted—Experienced man to take charge of sheet steel and machine work for gas ranges; must be a first class sheet steel man used to press work. "G. R. F.," AM. MACH.

Mechanical draftsman for technical paper illustrations; must be good rapid tracer and letterer; submit samples of work, state experience and salary wanted; permanent position in New York City. Box 305, AM. MACH.

Wanted—By large manufacturing company, an experienced salesman familiar with hydraulic and steam machinery; territory, South American countries; must speak Spanish; apply in writing, stating experience. Address "Hydrosteam," Post Office Box 824, New York.

Wanted—A-1 experienced tool designer, thoroughly familiar with modern high speed tools for the manufacture of work similar to typewriters, sewing machines, adding machines, etc.; must have first class references and be able to take charge of drawing room; state experience, age, nationality and compensation desired; all communications will be treated with strictest confidence. Box 315, AMERICAN MACHINIST.

OHIO

Salesman for a special line of machinery tools in a western territory; practical man with good references required. Address, with full particulars, Box 289, AMER. MACHINIST.

Wanted—First class machinists, toolmakers, die sinkers, lathe, planer, drill press, screw machine, boring and milling machine operators, wood and metal patternmakers, brass polishers, buffers, finishers, millwrights, hammermen and blacksmiths, who wish to increase their opportunities, to register with the free Employment Department of the National Metal Trades Association, New England Building, Cleveland, Ohio.

PENNSYLVANIA

Sales manager by a concern in eastern Pennsylvania, manufacturing ornamental and builders' iron work; must have executive ability with knowledge of estimating and costs; state age, qualifications and amount of salary expected. Box 271, AMER. MACHINIST.

The Monotype School is maintained to train young men to meet the constant demand for operators of our type casting and composing machine; these operators do so well that we receive more applications for places than can be filled; these qualifications carry most weight: Common sense, automatic machinery experience, printing office experience, type foundry experience. Full particulars will be furnished to inquirers who furnish the same information about themselves, and mention this paper. Lanston Monotype Machine Co., Philadelphia.

By small parts manufacturing company, whose product is recognized as first class, a man to take charge of department of standards; this department must pass upon work before going from the experimental department to manufacturing departments; must also pass inspections on parts and finished product in manufacturing departments; an excellent opportunity for a man possessing the necessary qualifications coupled with executive ability; salary secondary consideration; want the right man; location, eastern Pennsylvania; all communications strictly confidential and desire applications from men not accustomed to answering want advertisements. Box 310, AMERICAN MACHINIST.

WEST VIRGINIA

Wanted—Man with considerable mechanical experience, mechanical engineer preferred, to superintend large stamping and manufacturing plant; must have fair education and executive ability; state experience and give present employment. "Stamping," AM. MACH.

WISCONSIN

Expert tool designer, having shop experience as well as technical training in pressed steel work to take charge of tool drafting room for large stamping plant in Milwaukee; unusual opportunity for an ambitious and capable man; state salary and past experience. Box 166, AMERICAN MACHINIST.

SITUATIONS WANTED

Classification indicates present address of advertiser, nothing else.

MICHIGAN

Superintendent or foreman of drop forge department; fifteen years' experience and can give best of reference; will go anywhere, East or Middle West. Box 238, AM. MACH.

NEW JERSEY

Situation Wanted—Young man, 26, practical machinist, well versed in the construction and erection of steam engines, boilers, etc.; three years' special course mechanical drawing at Newark Technical School, would like position in engineering department of concern doing this class of work where honest endeavor would be appreciated. Box 304, AMERICAN MACHINIST.

NEW YORK

Machine tool salesman covering Greater New York, at present employed, desires to make a change. Box 313, AMER. MACHINIST.

Machine tool salesman covering Greater New York, at present employed, wishes to make a change; manufacturer preferred. Box 273, AMERICAN MACHINIST.

Man on developing inventions and manufacturing, desires to make change; thorough mechanic and designer with executive experience. Box 314, AMERICAN MACHINIST.

A highly efficient mechanic, with technical education, and inventive ability, wishes position taking charge of experimental shop, either with work of purely mechanical or electrical character. Box 298, AM. MACH.

Machine designer, 27, expert mechanic, broad experience in designing, manufacturing and layout of tools and special automatic machines for twist drills and general tools, desires position; will go anywhere. Box 285, AMERICAN MACHINIST.

OHIO

Wanted—To act as manufacturer's agent, commission only; selling machinery, machine shop tools and specialties and supplies; also electrical specialties. "Commission," AM. MA.

Works superintendent requires a position; thoroughly expert in modern methods of manufacture, machine tools, automobile and engineering specialties; machine tool concern preferred; age 36; American; best references. Box 312, AMERICAN MACHINIST.

PENNSYLVANIA

Draftsman, experienced on gas engines and producers up to 200 horsepower, desires position. Box 275, AMERICAN MACHINIST.

Mechanical engineer of sixteen years' experience, uptodate in modern shop practice, good organizer and systematizer, skilled in cost reduction and increase of output, desires position as engineer or superintendent. Box 302, AMERICAN MACHINIST.

General manager, superintendent, production specialist; over 20 years' machine shop, foundry and office experience on interchangeable system of tool, machinery and mechanical specialty manufacturing; age 37; references. Box 316, AMERICAN MACHINIST.

WISCONSIN

Man of good education and wide practical experience, wants position as foreman of tool job, or on experimental work. Box 307, AMERICAN MACHINIST.

FOR SALE

An opportunity to start a machine shop; we offer one of our departments for sale, the one used to establish our business; it is small and profitable work, but as we are devoting ourselves to heavier work, we offer to sell for $2000, all the drawings, patterns, and stock of finished and partly finished parts and rough material (inventories over $3000), circulars, electrotypes, special machinery and fixtures, and an established trade. Address Sipp Machine Company, Paterson, N. J.

Talks With Our Readers

By the Sales Manager

It is impossible here to give in detail what has appeared in the AMERICAN MACHINIST during the past year.

But, hitting the high spots, let's see what we have had, remembering that a page of the AMERICAN MACHINIST equals in size three to four pages of an ordinary technical book.

* * * *

There have been 169 authoritative articles by men of national and international reputation over their own signatures, and a number of others of equal importance under a pen name.

There have been 835 letters from practical men, containing kinks and money-saving suggestions.

596 new machine tools and appliances have been illustrated and described.

Accidents and their Prevention; 27 pages:
A subject interesting to everybody, from apprentice to manager, on account of the economies effected as well as from its humanitarian phases.

Aeroplanes; 40 pages:
Latest developments in air navigation from a strictly mechanical point of view.

Apprenticeship and Industrial Education; 85 pages:
Giving different plans and results obtained in solving one of the toughest problems confronting all of us today.

Automobiles; 115 pages:
Some devoted to design, but majority to construction and interesting methods of machining various parts as well as tools and fixtures used.

Designing; 72 pages:
This includes various kinds of machinery and jigs and fixtures for special purposes.

Drawing Room Practice and General Engineering; 89 pages:
Subjects closely allied to designing and drafting of special machinery.

Factory Engineering; 146 pages:
Design of shops, materials to be used for floors, transmission, etc., and shop and cost systems.

Forging and Welding; 40 pages.
Drop forging, oxy-acetylene welding, etc.

Foundry and Pattern Work; 89 pages.

Gearing; 60 pages.

Grinding; 45 pages.

Patents and Patent Law; 20 pages.

Railroad Shop Material; 47 pages.

Steel and Its Treatment; 86 pages.

Data in the Form of Tables and Inserts; 55 pages.

* * * *

Occasionally we get a kick about our devoting too much space to the building of machine tools; 69 pages have been given to this class of work while to other kinds of machine work, 201 pages. Of this, 72 pages to such small work as guns and typewriters and 35 pages to extremely large work.

Mathematical Articles:
The stumbling block of so many, have occupied only 18 pages.

Increasing Shop Capacities: 9366 items.
Showing where new equipment and machinery was needed; invaluable to the sales department.

* * * *

And last, but as important as any other part of the paper, are the advertisements of the progressive manufacturers of tools and equipment, which have appeared weekly. It has been our endeavor to have these as full of information and as truthful as it is possible to make them—a reliable and uptodate market-place for you.

The entire volume represents the progress of the machine-making industry during 1910—a mine of reliable and uptodate information to the live man responsible for results.

* * * *

Only reliable products can be continuously advertised.

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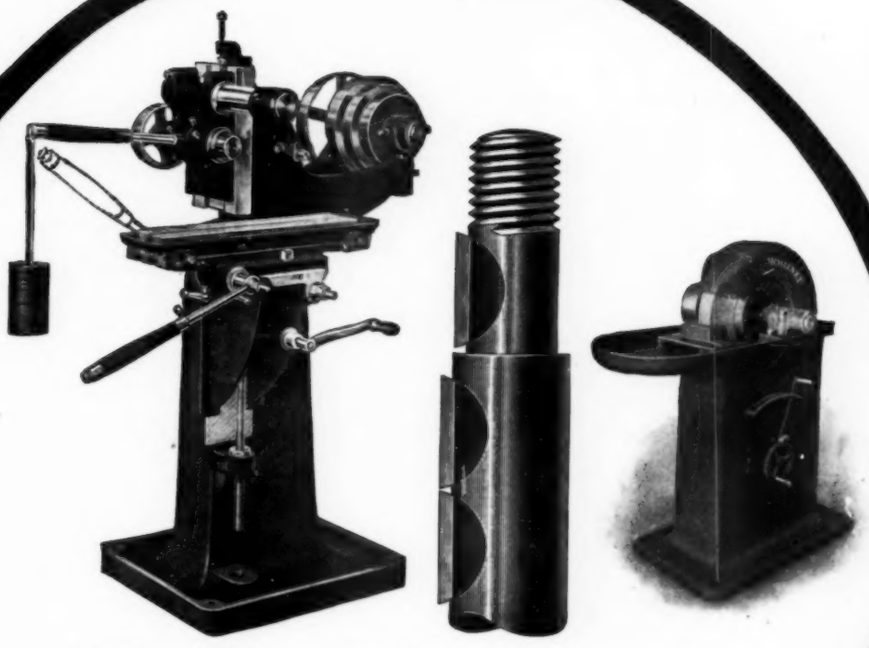

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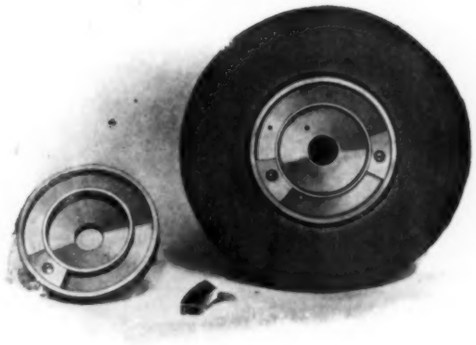

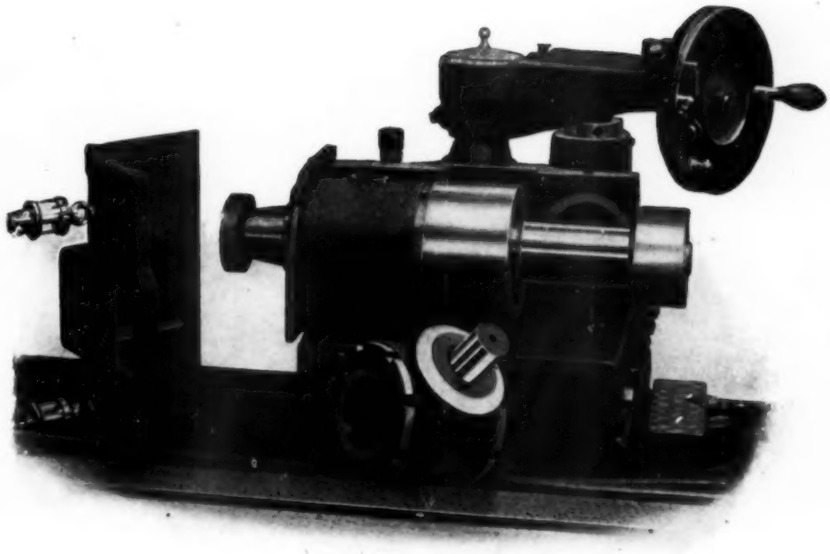

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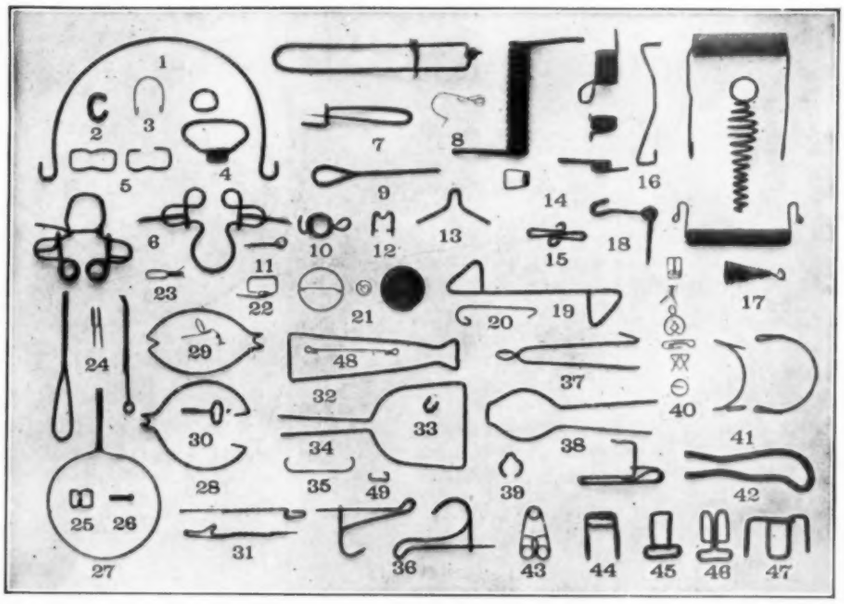

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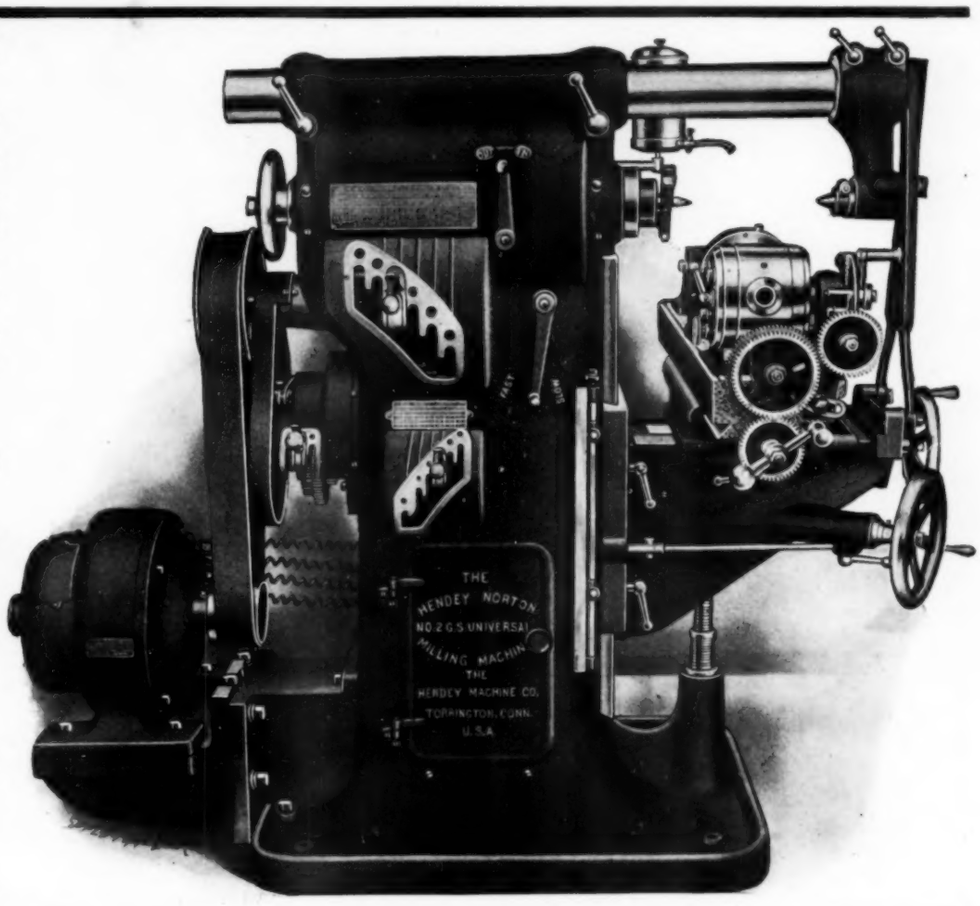

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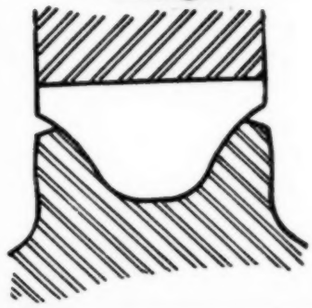

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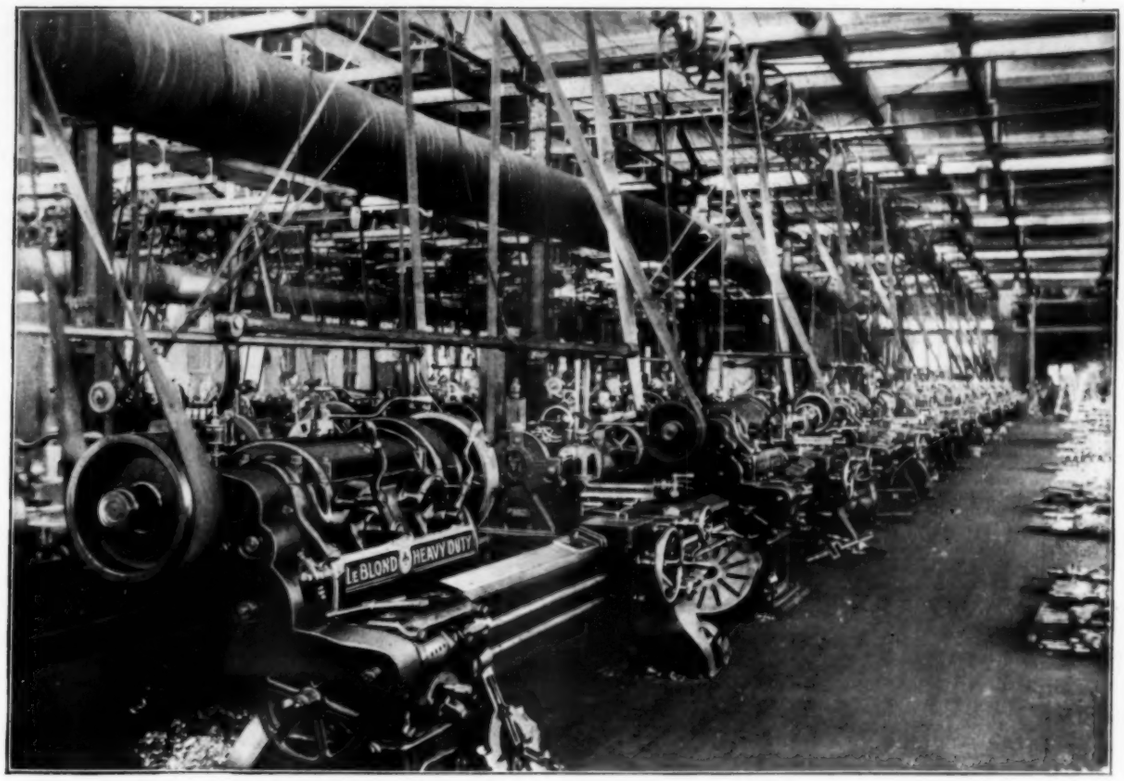

Lathe Costs

The reduction of lathe cost has been the stock argument of lathe manufacturers for so many years that it is getting threadbare.

This is not the old story, but a bit of evidence submitted for your consideration.

The installation of thirty LeBlond Heavy Duty Lathes shown above is in the crank shaft department of one of the largest manufacturers of automobile parts.

The equipment was purchased after a series of competitive tests had proven to this manufacturer that they were the greatest producers in the lathe field.

Another large manufacturer of Automobiles writes us that he is turning the pins on seventy-five four-throw cranks per day of ten hours.

You may not be interested in the manufacture of Auto parts, but the results stated are certainly indicative of what can be done on your own lathe operations.

We do not ask you to buy these lathes on the statements of a few of our customers, but will prove to you in your own plant and on your own work that these Heavy Duty Lathes will reduce your costs.

The R. K. LeBlond Machine Tool Co.

Cincinnati, Ohio.

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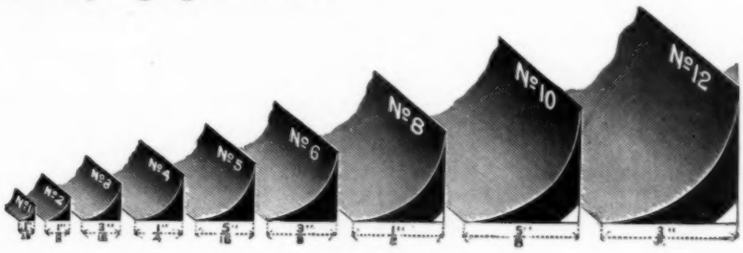

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Vise Stands
LeBlond Mach. Tool Co., R. K., 63 and 140
New Britain Mach. Co.....109
Tindel-Morris Co.....120
Western Tool & Mfg. Co.....120

Vises, Drill
Carter & Hakes Machine Co..111
Graham Mfg. Co..... 97
Jackson Vise & Tool Co..... 97

Vises, Metal Workers'
Brown & Sharpe Mfg. Co., 55 and 140
Carter & Hakes Machine Co..111
Graham Mfg. Co..... 97
Hammacher, Schlemmer & Co. 65
Jackson Vise & Tool Co..... 97
LeBlond Mach. Tool Co., R. K., 63 and 140
Millers Falls Co.....120
Parker Co., Chas..... 97
Reed Mfg. Co..... 97
Walworth Mfg. Co..... 50
Western Tool & Mfg. Co.....120

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Sanford Mfg. Co., F. C.....110
Toledo Electric Welder Co....107

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Billings & Spencer Co..... 99
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Coes Wrench Co..... 25
Hammacher, Schlemmer & Co. 65
Morse Twist Drill & Mach. Co. 59
Page-Storms Drop Forge Co..124
Trimont Mfg. Co.....119
Whitman & Barnes Mfg. Co.. 17
Williams & Co., J. H..... 82

Wrenches, Pipe
Bemis & Call Hardware & Tool Co..... 81
Billings & Spencer Co..... 99
Brosnihan Wrench Co.....118
Greene, Tweed & Co.....127
Reed Mfg. Co..... 97
Trimont Mfg. Co.....119
Walworth Mfg. Co..... 50
Wells & Son Co., F. E..... 89
Whitman & Barnes Mfg. Co.. 17
Williams & Co., J. H..... 82

Wrenches, Ratchet
Greene, Tweed & Co.....127
Parker Co., Chas..... 97
Pratt & Whitney Co., 2, 3 and 43 to 48
Trimont Mfg. Co.....119

Wrenches, Tap
American Tap & Die Co.....125
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Butterfield & Co.....125
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Smart Mfg. Co., A. J.....125
Standard Tool Co..... 26
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Who's Who And Where

FIND out for yourself by consulting the Buyer's Guide. A glance through this department helps the busy man to find out, in a hurry, who makes lathes, planers, milling machines or anything else advertised in the Selling Section of this paper.

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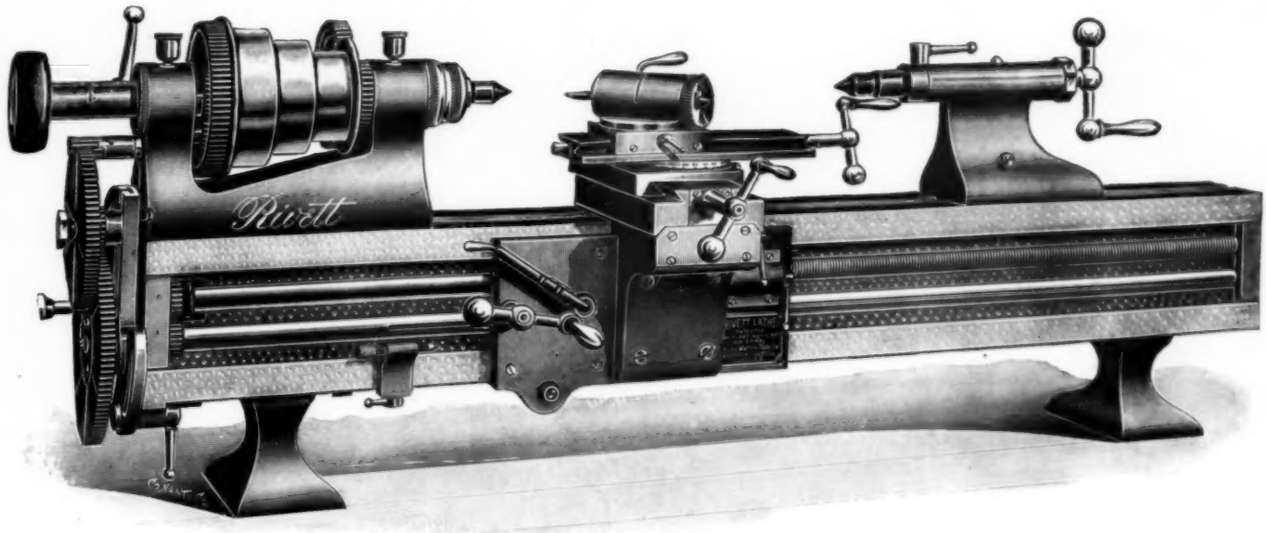

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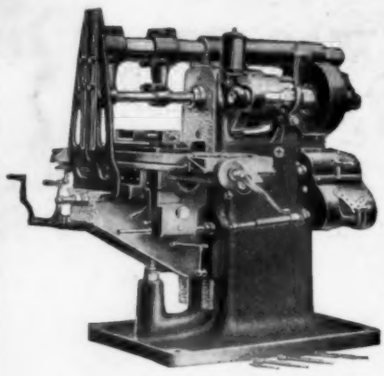

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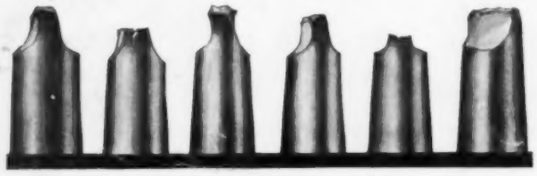

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